People and Excellence:
The Heart of Successful Commercialization

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Volume I: Final Report of the Expert Panel on Commercialization

Canada

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Preface

The Minister of Industry appointed us to the non-partisan Expert Panel on Commercialization in May 2005. We were asked to identify how the Government of Canada could help ensure continuous improvement in Canada's commercialization performance.

Specifically, our task was to examine how to transform knowledge and technologies (whether developed in Canada or abroad) into new products, services and processes in response to market opportunities; how to ensure that new knowledge and technologies generated using public funds will lead to practical applications; and whether Canada has created the right business environment for commercialization.

Our various backgrounds and expertise in the private, public and academic sectors provided the opportunity to develop a cohesive, practical road map. We acted as individuals on the panel, not as representatives of our organizations, industries or communities.

We approached the task in a number of ways. We reviewed the evidence-based research available to help us in our deliberations, and sought the advice of those in the business, academic and public policy arenas. Eight experts from across the country and abroad then reviewed the report. We discussed these findings and recommendations among ourselves, and applied our own knowledge and experience to what became robust, lively debates.

Our discussions led us to focus on three areas – talent, research and capital. The recommendations we are submitting come with our unanimous approval, and reflect our principles and values and the criteria we used to assess new programs, as set out in Appendices B and C. The recommendations in this report are submitted recognizing that we are in a fierce global race, and that our commercialization system must be integrated and consistent, yet flexible and adaptable.

The report calls for a systemic approach and immediate action. Its underlying premise is that successful commercialization occurs when the supply of high-quality ideas and research is met by a demand from competitive businesses for innovation. People and excellence connect ideas to the marketplace.

We would like to thank Industry Canada for the services of the Expert Panel on Commercialization Secretariat, and would like to thank the Secretariat itself for its tremendous help in preparing this report. We deeply appreciate the contributions of the people who provided input, especially those who reviewed drafts of this report. We are grateful for the opportunity to make this contribution. It has been a privilege.

Joseph L. Rotman

Joseph L. Rotman, Chair

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Executive Summary

Canada at the Crossroads

The Challenge of a Competitive World

By any standard, Canada's economy is performing well. We are enjoying a period of growth not seen since World War II. Unemployment rates are at record lows, and our ratio of debt to gross domestic product (GDP) is steadily declining. But the past is not prologue, and we face significant challenges. Emerging economies such as China and India are industrializing at a rapid pace, creating exciting market opportunities but also putting strong pressure on our traditional manufacturers. Other countries are responding to these new realities by adding value through investments in innovation.

In such a world, Canada's weak productivity – particularly in relation to our largest trading partner, the United States – argues forcefully for a renewed commitment to bolstering commercialization.

Today, Canada has a unique opportunity – to build, from our current economic strength, an enduring national advantage, and to excel in expanding the critical capacity to translate the ideas in our heads into products, processes and services in the market. The latter is the key to success in a world where competition is global, change is rapid, and knowledge is a critical source of competitive advantage. But, first, we must act.

Reviewing Options, Making Choices

Documenting Canada's strengths and weaknesses in terms of commercialization is relatively straightforward. However, there is no consensus on **why** Canada's performance on this score lags behind those of its competitors – and there is even stronger disagreement on what our governments can do to improve the situation.

For our part, we decided to focus on issues where prompt action was possible. We saw our task as one of suggesting ways to improve, enhance and invigorate a commercialization system that works, but can work much better.

Indeed, many components of Canada's commercialization system are functioning well, and these should be reinforced. This is particularly true with respect to developing a talented workforce and supporting publicly funded research.

Canada does face a significant challenge, however, in the low level of commitment by many Canadian businesses toward research and the many other facets of innovation, especially in comparison to these levels of commitment among Canada's major competitors. These failings do much to explain Canada's relatively weak commercialization outcomes.

We have developed a comprehensive package of 11 recommendations to provide a strong starting point for Canada to achieve its full potential. At the core of these recommendations is the development of a new role for the private sector as a full partner in charting the course for, and developing policy related to, commercialization.

A New Model of Leadership – The Commercialization Partnership Board

Successful commercialization is market-driven, but, at the moment, there is a fundamental disconnect between the people who make commercialization happen and government efforts to encourage it. More must be done to ensure that the private sector has a strong voice in the design of public policies to improve commercialization in Canada.

The creation of a business-led Commercialization Partnership Board (CPB) would help change this dynamic. The CPB would be the lead advisory body to the Minister of Industry on commercialization issues. It would provide guidance on changes to existing government programs, the creation of new programs and the assessment of results. It would also commission policy-oriented research on key long-term challenges, including business framework issues such as taxation, regulation, intellectual property and competition.

The Government of Canada should act on the insights and expertise of the Board, which would provide advice on how to continually improve the policies and programs that support Canada's commercialization performance. Specifically, the CPB would:

- submit an annual report to the Minister of Industry, who would respond on behalf of the government; and
- identify strategic opportunities for Canada to build on its competitive advantages and exploit emerging opportunities.

Supply and Demand

There are two sides to successful commercialization – the supply of ideas and people, and the demand from the marketplace for new products and processes.

Canada has come a long way in addressing the supply side of the commercialization equation. It has increased funding for university research that produces both the knowledge and the talented people needed for commercialization, and it has employed tax measures to attract risk capital.

But there is a broad range of evidence that Canada is still struggling on the demand side – in the **pull** from the private sector. For example, Canadian businesses employ fewer researchers and university-educated business managers, perform less research, and win fewer and smaller risk capital deals than do their U.S. counterparts. The panel believes that while Canada needs to expand and renew its supply-side measures, it must now focus its efforts on the demand side, reducing the barriers and perceived risks that make businesses reluctant to engage in commercialization.

Three Themes for Action

Successful commercialization has many elements: critical management skills, vision and a highly qualified workforce are vital; scientific and technological discovery are important for all sectors of the economy; and access to capital at each stage of a company's life is essential.

To kick-start the process that would be sustained through the CPB, the panel has identified three specific areas that require early action by the federal government. These three areas – talent, research and capital – all share a common focus on people and excellence:

- People turn great ideas into new products and services, making the strategic business choices that result in commercial success.
- People engage in research, generating ideas that have commercial potential.
- People use capital to move through the many stages leading to successful commercialization.

Focusing on **people** and **excellence** in these three areas will make a difference for Canada in the global race to compete.

TALENT

Since it is people who develop ideas and move them to the marketplace, Canada needs to increase the presence of highly qualified workers and managers in Canadian businesses. Our recommendations on talent also reflect the need to raise the demand for highly qualified workers in business, while continuing to promote excellence in the skills needed for commercialization. Measures in these areas will also strengthen the demand for innovation and commercialization. We see particular benefit in programs that place skilled students and recent graduates in business settings. Such programs not only improve the ability of companies to commercialize, but help refine the skills that graduates need to make smooth transitions to the business sector.

To foster a supply of talented workers, we must maintain strong support for Canada's post-secondary education system, undertake greater efforts to attract more of the world's leading minds to this country, create employment opportunities, and encourage Canadians to gain exposure to other cultures and markets. Finally, Canada must bring about a long-term change in its culture to ensure business and technical achievement are valued more highly. To achieve this, attention should be focused on Canada's youth. We recommend initiatives that will:

- **increase business demand for talent, through the development of a new Canada Commercialization Fellowships Program;**
- **spur private sector hiring of highly qualified personnel with commercialization talents;**
- **encourage and celebrate young Canadians who aim for success in science, technology and business; and**
- **develop and retain talent for success in the global marketplace.**

RESEARCH

There is substantial research activity in Canada, but too little takes place within the private sector. The challenge for government is to increase – not merely maintain – its investments in publicly funded research, while encouraging private sector research and development (R&D). Business leaders, in collaboration with publicly funded research institutions, can identify areas for research and skills development that will position Canada for global leadership.

Small and medium-sized enterprises (SMEs) are pivotal players in business supply chains. With further support, they can build the bases needed to attract additional capital and employ more talent. In particular, seed and start-up firms can benefit from government support at the earliest and most risky stages of product and service development to help them overcome gaps in the financing marketplace. Experience from other countries points to approaches that can address government needs while encouraging research by SMEs.

We recommend initiatives that will:

- **create a Commercialization Superfund to address key commercialization challenges;**
- **expand federal programs that support seed and start-up firms in proving their business ideas; and**
- **increase the commercialization involvement of SMEs, through a Canadian SME Partnerships Initiative.**

CAPITAL

Finally, Canada must ensure that its capital markets are working effectively, getting funding and management expertise to promising commercial opportunities. One immediate goal should be to stimulate increased investment by angel investors, who provide firms with both financial capital and, in some cases, the benefit of their experience, contacts and mentorship.

The panel also proposes a series of tax measures to promote greater influxes of foreign capital and expertise. We also believe an in-depth analysis of how Canada can improve the climate for venture capital investment is also required, with the objective of strengthening the investor community and improving the quality of business opportunities.

We recommend initiatives to:

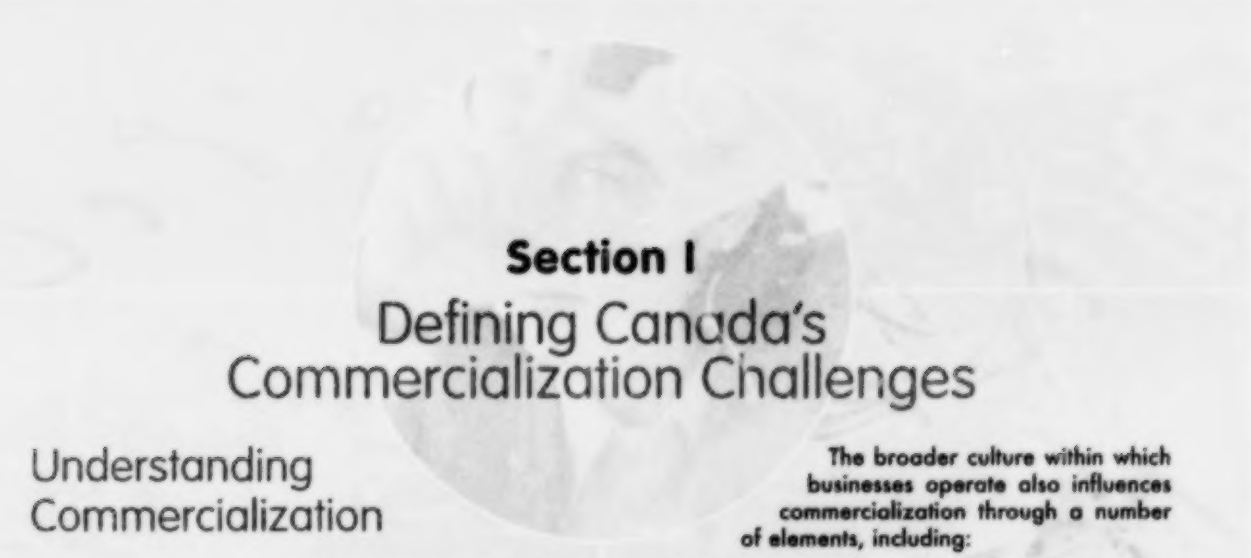
- **improve access to early-stage angel financing and expertise;**
- **review and identify improvements in Canada's expansion-stage venture capital market; and**
- **remove barriers to investment for foreign venture capital investors.**

Summing Up

Many others have reached the same conclusions and proposed similar recommendations as this Expert Panel on Commercialization. The key is execution. In this respect, our report and its recommendations are only a start. The panel believes that two key steps are required to position Canada as a recognized leader in the global marketplace:

- creating, through the CPB, stronger relationships among the business sector, the federal government and other key institutions such as universities; and
- acting immediately in the specific areas where needs exist, with these actions monitored by the CPB to ensure concrete results and enable further decisions.

Creating the CPB is a crucial first step in these processes.



Section I

Defining Canada's Commercialization Challenges

Understanding Commercialization

Commercialization includes everything a firm does that transforms knowledge and technology into new goods, processes or services to satisfy market demands. Commercialization is applicable across all economic sectors and is as relevant to Canada's natural resource industries, manufacturers and service providers as it is to its advanced technology companies.

Commercialization is anchored in the world of business and is affected by many factors, including:

- the pull of the marketplace;
- the flow of ideas through research efforts within the firm and from outside it;
- financial, operational and human resource strengths;
- the quality of the market information available for decision making; and
- whether the corporate culture values innovation and a focus on customers, and accepts that trial and error, risk, and failure are normal bumps on the path to success.

The broader culture within which businesses operate also influences commercialization through a number of elements, including:

- the public sector's framework of laws, policies, programs and supports, including those related to intellectual property, regulation and tax regimes;
- the degree to which competitive forces drive innovation throughout the economy;
- the role of publicly funded research and education in generating knowledge, and the roles of skilled people who know how to create, build on and apply this knowledge;
- the encouragement of alliances, networks and other forms of connections among businesses, governments, educational institutions and other partners; and
- whether society in general views personal achievement and business success as positive values.

Two elements are at the heart of commercialization – people and excellence. People identify market opportunities, carry out research, train others, make investment choices, build networks and create successful businesses. People, therefore, are the ultimate competitive advantage.

Excellence determines who wins in the face of emerging market opportunities, and can be seen in commitment to a talented, highly trained workforce; world-class research; and far-sighted investment.

The Case for Action

Why is it so essential to foster commercialization in our economy?

Despite the fact that Canada's economy is performing well, there are significant challenges on the horizon. First, today's economy demands that organizations in all sectors create value by adding knowledge. Second, our workforce is aging, threatening our ability to sustain strong economic growth unless workers are given the tools to add more value. Finally, Canadian businesses are facing increased competition from nations such as China and India, which are just beginning to realize their industrial potential.

Improving Canada's productivity growth will be crucial to meeting these challenges. Unfortunately, Canada does not have a strong recent track record in this area. Productivity growth in the Canadian business sector averaged only 0.7 percent per year from 2000 to 2005, a sharp slowdown compared with previous years, and a much poorer record than that of the U.S., our major trading partner.

An important element of Canada's productivity challenge is its inability to capitalize on innovation and discover new and better ways to add value to what it sells. The key to solving this is in commercializing knowledge – the surest path to enhancing productivity and sustaining economic prosperity. Enhancing productivity will also help to close the prosperity gap that has opened between Canada and the U.S. – a gap that now accounts for a difference of about US$8200 in average annual income between Canadians and Americans.[1]

Commercialization in Canada: How Are We Doing?

Commercialization does not lend itself easily to measurement, but a number of indicators suggest that Canada lags behind its major international competitors. European firms tend to derive a higher proportion of total sales from recent innovations than their Canadian competitors. Sales from new or improved products accounted for 35 percent of all sales by Canadian firms having Canada-first or world-first innovations. This figure is 54 percent in Germany.[2] Data for the U.S. is not available.

Ontario's Institute for Competitiveness and Prosperity found that Canadian firms lag well behind their U.S. counterparts in terms of patents granted per 10 000 employees, an important indirect measure of commercialization, even when firms in the same business sector are compared.[3] The use of information and communications technologies used to embed knowledge in services and products has risen in Canada, but at a slower pace than in countries such as the U.S. and Finland.

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1. Organisation for Economic Co-operation and Development, *OECD in Figures* (Paris: Organisation for Economic Co-operation and Development, 2005).
2. Pierre Mohnen and Pierre Therrien, "How Innovative are Canadian Firms Compared to Some European Firms? A Comparative Look at Innovation Surveys," *MERIT-Infonomics Research Memorandum* series, 2001-033 (July 2001).
3. Roger L. Martin, *Realizing Canada's Prosperity Potential* (Toronto: Institute for Competitiveness and Prosperity, 2005).

This economic evidence of lagging Canadian commercialization is backed up by survey data showing that Canadian businesses prefer strategies based on cost containment rather than innovation. In 2001, fewer than 40 percent of businesses in Canada considered developing new products or production techniques as important to their business strategy. More than half, however, believed that reducing labour and other operating costs was important. The most recent *Global Competitiveness Report* ranked Canadian businesses 27th overall in their propensity to compete on the basis of unique products or processes rather than low-cost labour or raw materials.[4]

These findings suggest that changing Canada's prevailing business culture will be the country's main commercialization challenge. Corporate strategies must shift toward competing on the basis of excellence and innovation – including new, higher-value products, services and processes – through better commercialization of ideas across all sectors of Canada's economy. Implementing such a strategy will require firms to increase their capacities in talent, research and capital.

Our review of the evidence indicates that Canada has in place many of the investments needed to support innovation: public funding for R&D, a solid infrastructure of colleges and universities, and a business environment conducive to innovation. Canada's real opportunity for improvement is in increasing business demand in order to achieve a greater return on these investments.

DRAWING ON THE PANEL'S EXPERIENCE, EXPERTISE AND BEST JUDGMENT

The panel members have substantial experience as leaders of organizations in the private and academic sectors. We, therefore, not only assessed the evidence but also drew on our collective experience and applied our own judgment.

We vigorously debated what was practical and achievable. From these debates we developed a shared view on many issues, most importantly, striking the right balance between supply measures – those that improve the supply of talent, commercialization-directed research and capital – and demand measures that will encourage Canadian businesses to commercialize.

It is necessary to make informed choices about Canadian business framework policies such as taxation, regulation, competition and intellectual property protection. We are well aware of, and sympathetic with, recommendations in these areas from individuals and groups whose counsel we respect. However, given that the federal government has reviewed many of these issues in other forums, and that we have limited time and resources, we saw little value in duplicating this other work.[5] Further, our expertise and knowledge lay elsewhere.

Finally, we recognize that the relationship between successful commercialization and many broad framework policies is not always clear.[6] Section IV of this report sets out our views on the need to analyze these business framework issues in detail.

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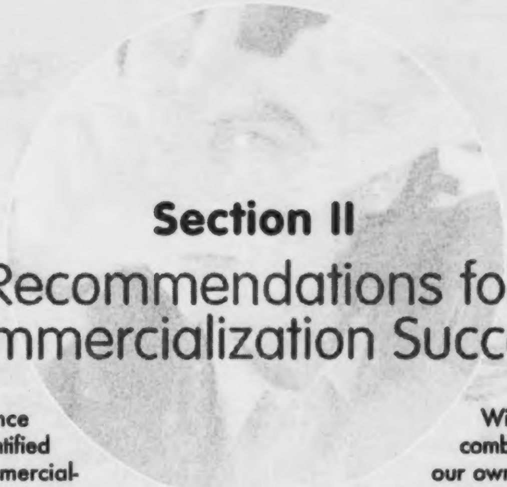
[4] World Economic Forum.

[5] For example, the federal government has received recommendations from the External Advisory Committee on Smart Regulation.

[6] For example, the National Science Advisor has noted that there is no strong relationship between corporate tax rates and private sector R&D efforts. Countries that have low corporate taxes (e.g. Sweden and Finland) tend to be leaders in business R&D, but countries that have higher rates are not far behind (e.g. Japan, the U.S. and Germany).



Section II

Recommendations for Commercialization Success

From our review of the evidence and our own experience, we identified three core elements of the commercialization system in Canada in which change could have the biggest impact:

Talent – by ensuring that Canada creates, attracts, retains and employs the full range of talents needed for sustained commercialization and fosters a culture of internationally competitive excellence in all fields.

Research – by building on the existing Canadian bases of R&D in traditional science and technology disciplines and in fields such as design, market research and business management.

Capital – by increasing the capacity of smaller and younger firms and entrepreneurs to gain access to the capital needed at different stages of the commercialization process.

Within each of these elements, we combined the available evidence with our own experience to assess the situation facing Canada and develop recommendations. The result is a set of recommendations that form a comprehensive, practical and achievable package. We structured many of these recommendations so that they would begin as pilots and be scaled up or down based on new evidence, results and the best opportunities available to improve commercialization.[7]

We believe that the federal government's commercialization policies do not adequately address the demand side of the commercialization equation. For example, while Canada provides generous tax incentives for business R&D, it continues to underperform in this area. The reasons for this are complex, but this underperformance indicates that the current approach is not meeting private sector needs (since they have not changed their behaviour in response to these incentives). Correcting this will require more private sector input into the design of support programs. The Government of Canada has no formal body dedicated to engaging business people on these issues. However, demand considerations must be the cornerstone for decision making. Our recommendations begin by addressing this gap.

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7. The appendices of this report (published in a separate volume) provide more detailed evidence and analysis of the issues that led the panel to its conclusions and recommendations. The recommendations have been designed so that existing institutions can take responsibility for implementing them, although other approaches have been proposed where the panel could not find an obvious choice among potential implementing organizations.

RECOMMENDATION

Create a Commercialization Partnership Board

PROPOSAL

We recommend that the Government of Canada create a Commercialization Partnership Board (CPB) reporting to the Minister of Industry as his or her lead advisory body on commercialization. Its mandate would be distinct from those of other advisory bodies. It would:

- make recommendations with respect to the major commercialization initiatives we are proposing, such as the Canada Commercialization Fellowships Program, the Commercialization Superfund, a new Angel Co-Investment Program and the Canadian SME Partnerships Initiative (described below);
- serve in an oversight role for federal commercialization policies, initiatives and investments, and provide an annual public report evaluating their effectiveness, integration and impacts;
- call on the Minister of Industry to respond publicly to the above-mentioned report;
- assess the implementation of the recommendations in this report, identify improvements, and advise on when it is appropriate to move from pilot to full-funding status for each recommendation;
- encourage linkages to, and coordination with, the many provincial/territorial government strategies and organizations working to support commercialization;
- build support in the private and public sectors for a sustained effort to improve Canada's commercialization outcomes; and
- provide policy-focused advice to the Minister on improving commercialization in Canada, including guidance on government–business framework issues such as the competitiveness of internal markets, regulation, intellectual property protection and taxation.

To do this, the CPB must be:

- rooted in the marketplace;
- focused and strategic in its advice;
- led by a respected commercialization expert from the private sector, with members who are knowledgeable, experienced and committed to getting results for Canada;
- driven by a culture of commerce and an awareness of the most current domestic and international commercialization realities; and
- focused on the need for better evidence on commercialization in Canada.

The Minister of Industry would appoint a full-time president who would devote his or her time and resources to ensure, through personal leadership and continual interaction with the community at large, that commercialization is kept at the forefront of public and economic thinking in Canada. Other CPB members should be drawn from the business community, academia and organizations focused on commercialization-related goals bringing partners together from all sectors (commonly known as fourth-pillar organizations).[8] These members should reflect the entire commercialization system but not be collectively or individually accountable or beholden to any other organization or mandate while exercising their responsibility. At least one member should be from outside Canada so that the CPB can draw on international best practices. Officials from key government research and commercialization organizations should be included as ex officio, non-voting members. Deputy ministers would be asked to attend when it is relevant to their departments.

The CPB would require the support of an independent, full-time secretariat, whose executive director would be selected by, and accountable to, the president of the CPB.

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[8] Fourth-pillar organizations are usually independent, non-profit entities funded jointly by government and the private sector to provide a catalytic role for the other three pillars: business, government and post-secondary education institutions. For example, Precarn Incorporated was created, and is funded, by partners from these three pillars to support the development of intelligent systems technologies.

To create the CPB, an interim board would be established with a one-year mandate to do the following:

- Develop an implementation plan for the recommendations of the panel, monitor the implementation of these initiatives, develop a plan for assessing their outcomes, and provide recommendations for improving, modifying or cancelling initiatives.
- Develop terms of reference, a budget, strategic plans and timelines for the creation of the CPB and ensure a clear mandate, as outlined, for the organization. This mandate will be distinct from those of other bodies with broad advisory mandates, such as the Prime Minister's Advisory Council on Science and Technology and the Council of Science and Technology Advisors, because it is focused strictly on commercialization. It will also differ from the proposed national advisory board of the pilot projects to commercialize university and federal laboratory research, in that the CPB will focus on private, rather than public, commercialization issues. The panel expects, however, that the CPB will work closely with the bodies mentioned in areas of common interest.
- Nurture collaboration between the private, public and other sectors, particularly in areas where Canada has, or could develop, a competitive advantage in commercialization, and where private sector commitment to commercialization can be increased.

The CPB itself should have an initial four-year mandate. After that, its effectiveness should be reviewed by an internationally recognized panel of experts on commercialization, to determine whether it should continue, be changed or be cancelled.

The interim board should be provided with an annual budget of $3 million. The board would, in turn, recommend a budget for the CPB. This budget would be reviewed periodically.

TALENT

Canada's competitiveness and capacity for commercialization depend on the talent and ingenuity of people who combine knowledge and resources in new ways. Canada needs a well-educated workforce whose skills, knowledge and creativity can compete with the best in the world – and it needs to put their skills and education to work in a way that spurs innovation and benefits businesses.

In many respects, Canada is doing well in the supply of talent. Among 15-year-olds, Canadians are exceeded in their math abilities only by students in Hong Kong and Finland.[9] Canada ranks first among Organisation for Economic Co-operation and Development (OECD) countries in terms of the share of its working-age population with post-secondary education. But this same OECD data reveals that we have proportionately fewer university graduates and – at the very high end – we are producing new PhD graduates at a much slower pace than major competitors such as the U.S.[10]

More fundamentally, there is concern about the extent to which Canada's universities have the capacity to significantly increase the number of graduate students. In particular, the Association of Universities and Colleges of Canada estimates that U.S. universities have 50 percent more funding per student for teaching and research.[11]

The Government of Canada has partly addressed these problems by establishing programs such as the Canada Millennium Scholarship Foundation and the Canada Graduate Scholarships to allow more Canadians to pursue a post-secondary education. Federal funding has also been increased for the granting councils and other funding organizations, in order to support Canada's research community. But these problems are a moving target, and Canada cannot afford to rest on its laurels.

As noted, a greater challenge for Canada's commercialization performance is inadequate demand for talent. In general, Canadian businesses have a weak record for hiring people with the skills needed for the full range of commercialization activities. For example, Canadian managers are only half as likely as American managers to be graduates of business programs. Among financial professionals, 18 percent in the U.S. have a master's degree or higher, compared with only 8 percent in Canada.[12] And, U.S., Japanese and German companies employ significantly more researchers per thousand employees than do Canadian firms.[13]

Most tellingly, the wage premium for highly qualified personnel is lower in Canada than in competitor countries, particularly the U.S. The wages for highly skilled workers have not risen relative to the Canadian average in recent years.[14]

Placing highly qualified personnel – from all education disciplines – in business environments will spur demand by influencing the way firms create opportunities, encourage greater involvement by firms in research, increase the flow of knowledge to businesses from academia, and broaden understanding of international markets.

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[9] Human Resources Development Canada; Council of Ministers of Education, Canada; and Statistics Canada. *Measuring Up: The Performance of Canada's Youth in Reading, Mathematics and Science. OECD PISA Study – First Results for Canadians Aged 15.* Catalogue No. 81-590-XPE. Ottawa: Statistics Canada, December 2004.

[10] Organisation for Economic Co-operation and Development, *Education at a Glance 2005* (Paris: Organisation for Economic Co-operation and Development, September 2005). The comparison of PhD graduation rates was taken from the 2002 issue, given that recent data for Canada is not available.

[11] Association of Universities and Colleges of Canada, *AUCC Backgrounder: Canada–U.S. Funding Comparisons* (Ottawa: Association of Universities and Colleges of Canada, 2005).

[12] Based on census data from Statistics Canada and the U.S. Department of Commerce.

[13] Organisation for Economic Co-operation and Development, *OECD Science, Technology and Industry Scoreboard 2005* (Paris: Organisation for Economic Co-operation and Development, October 2005).

[14] See, for example, René Morissette, et al., *Relative Wage Patterns among the Highly Educated in a Knowledge-based Economy* (Ottawa: Statistics Canada, 2004).

RECOMMENDATION

Increase Business Demand for Talent Through Development of a New Canada Commercialization Fellowships Program

PROPOSAL

We recommend that the federal government create a new Canada Commercialization Fellowships Program. The program would support businesses in all sectors that are building or renewing a commitment to commercialization by supporting exchanges with post-secondary institutions. These fellowships would encompass the broad range of disciplines that support commercialization, such as management, marketing, market research and design, as well as the sciences, technology and engineering. These exchanges will happen throughout the career cycle:

- Undergraduate Fellowships will provide work experience and scholarships for Canadians entering a university in Canada. The winners of the regional and national science fairs and youth business competitions discussed later in this section should qualify automatically for these fellowships.
- Graduate Fellowships for master's and PhD students in Canadian universities will give participants work experience, training and research skills in both university and business settings in order to improve their ability to bring commercialization skills to Canadian workplaces.
- Post-Doctoral Fellowships will include support for specific efforts in order to bring ideas to market and provide funding for training and research that are relevant to commercialization.
- Career Interchange Fellowships will concentrate on two areas:
  - the temporary or part-time movement of post-secondary faculty into industry, and of people from industry into academic environments, creating a cycle for fellows to move ideas between both sectors; and
  - a mentoring and exchange program for a select group of mid-career professionals and next-generation angel investors and venture capitalists, who will work in, and learn from, successful venture capital firms in Canada and around the world, enabling the fellows to apply international best practices to commercialization in Canada.
- Chairs of Research in Practice will focus on people that have PhD degrees and substantial experience in industry and/or academia in Canada. The funding for these chairs will support multi-year projects that include the supervision of graduate students; direction of a research team in a business, not-for-profit organization or public research institution; and management of a project that will add to commercialization knowledge and its application.

The intentions of the Canada Commercialization Fellowships will be to encourage students not inclined to business to explore this option, and to encourage firms not currently employing high-end talent to do so. These intentions must be reflected in the program's design.

The dollar value of the fellowships must be irresistible in order to attract and retain the best and brightest from around the world. Funding decisions for all of these fellowships should be guided by how well proposals expand business demand for people with the skills needed for commercialization. After a reasonable tenure, the cost of continued employment with the firm would be borne by the company.

Program administration will involve two complementary parts. One part will assess fellowship candidates' qualifications in much the same way that applicants for scholarships and research grants are currently evaluated. The second part will assess how well proposals will improve the commercialization-relevant skills of the candidates and the commercialization capacity and outcomes of the host and/or home organization(s). Ensuring that a delivery organization has the ability to assess both the demand and supply elements of the program will be a key challenge for the CPB in its oversight function. The CPB will need to ensure that the fellowships add to any existing initiatives so that firms can gain new perspectives on commercial opportunities through the application of knowledge.

REASONS FOR ACTION

Canada is growing the supply of talent, and it must strengthen private sector demand for that talent. In our view, the way to do this is by reducing the initial costs. Once in place, the fellows will demonstrate their value, change the culture of their workplaces and make commercialization self-sustaining.

Funding Requirements and Expected Results

The panel estimates that funding for the Canada Commercialization Fellowships should begin at $65 million per year on a pilot basis, scaling up to $275 million per year once their effectiveness has been confirmed by a CPB-led review. This would provide funding for up to 5000 fellowships and associated research budgets in any one year. The panel expects that the fellowships will:

- increase the number of highly talented workers with commercialization-relevant experience in both academic and business settings;
- increase the capacity for, and commitment to, innovation and commercialization among Canadian companies; and
- improve the flow of knowledge from academia to business on recent scientific developments, and from business to academia on market needs.

RECOMMENDATION

Spur Employer Hiring of Recent Graduates with Commercialization Talents

PROPOSAL

We recommend that the federal government increase existing support to Canadian businesses to hire recent graduates on projects aimed at commercialization and innovation by:

- **expanding the existing Canadian Institutes of Health Research (CIHR) programs that focus on industry-university partnerships;**
- **expanding the existing Natural Sciences and Engineering Research Council of Canada (NSERC) programs that provide research experience in industrial settings;**
- **creating a new Social Sciences and Humanities Research Council of Canada (SSHRC) commercialization and innovation fellowship program emphasizing disciplines such as business, design and human behaviour; and**
- **providing funds to these organizations based on a competition overseen by the CPB.**

The federal government should support this recommendation by increasing funding for the granting councils involved, not by reducing funding for existing programs. What's more, this new money must be complemented by more aggressive campaigns aimed at Canadian employers to demonstrate the benefits of drawing on Canada's highly qualified graduates to spark innovation and commercialization.

REASONS FOR ACTION

The two organizations at the centre of this recommendation, NSERC and the CIHR, are already demonstrating their value in driving Canadian commercialization. They are improving the quality of the supply of talent and linking these people to demand opportunities. For example, the number of university-industry fellowships approved by the CIHR increased from 171 in 2000 to 324 in 2004 (in response to a near tripling in applications over this period). On average, more than 60 percent of people supported by NSERC's program are retained by the related firm, at the firm's expense. While the number of projects funded is not large, it shows growing interest in creating opportunities for talented people to make their mark in Canada's business sector.

While the CIHR and NSERC programs are valuable, they cover only part of Canada's commercialization needs. Adding a new program through SSHRC would incorporate other fields critical to commercialization.

We recognize that the programs of these three organizations will continue to be highly targeted and focused on opportunities for the most highly trained graduates. However, they fit with the larger need to create stronger bridges that enable highly qualified personnel to make the transition from Canada's universities to businesses and other applied settings.

Funding Requirements and Expected Results

The panel estimates that funding for the three programs mentioned should increase by $15 million per year, initially, scaling up to an additional $40 million per year following a CPB-led review of their effectiveness. This would roughly double the amount of funding now provided to these organizations for this purpose. The panel expects that this recommendation will:

- increase private sector demand for commercialization talent through higher overall employment and an increased number of hiring companies;
- lead to reduced emigration of highly skilled Canadians in fields that are the focus of fellowships, while enhancing the recruitment of Canadian students who have studied abroad; and
- improve the flow of knowledge crucial to commercialization from academia to Canadian businesses through increased hiring of recent graduates by industry.

RECOMMENDATION

Encourage and Celebrate Young Canadians Who Aim for Success in Business, Science and Technology

PROPOSAL

We recommend that the federal government provide substantial, guaranteed and long-term support for initiatives that promote and celebrate excellence in science, technology and business by young people. This will mean much more than incremental funding for science fairs, student business competitions and similar activities across the country. It must involve:

- granting Canada Commercialization Undergraduate Fellowships and other awards to high school students who win major academic and business skills competitions;
- creating the Prime Minister's Awards for Science, Technology and Entrepreneurship for Canada's Youth to send a powerful message to young people and their communities;
- launching an annual, national event involving the Prime Minister to honour the young achievers who will help to build our commercialization future;
- initiating new awards to honour leading-edge innovation by young people in new or non-traditional fields that encourage intellectual and commercial risk taking; and
- establishing new awards to celebrate the success of young people commercializing new products, services and processes.

We recommend that a competitive process be developed to provide sustained, long-term funding to local and national organizations that can demonstrate the ability to meet the goals of this recommendation.

REASONS FOR ACTION

If Canada is going to foster a culture that promotes intellectual achievement and business success, it must begin with its young people.

From our experience, interest in and an aptitude for science or business develop early in life. Activities for school-aged children that fuel curiosity and develop creativity build on that early childhood base – activities as pivotal in a student's life as winning the school science fair. The panel's recommendations, and other government actions, will encourage young people – including young women and members of other under-represented groups – to pursue careers in science, technology and business.

Of high school students attending Canada-Wide Science Fairs in 1995 and 1996, 57 percent expressed an interest in pursuing science-related careers, compared with only about 37 percent among those who did not attend. These fairs are where children can learn scientific and business skills and put them to work. Federal leadership will provide a great incentive for Canadian companies to expand their commitment to these activities and help foster a culture of excellence in Canada's classrooms and labs. Canada should prize excellence in these areas the same way it prizes excellence on the ice.

Funding Requirements and Expected Results

Funding requirements for this initiative are estimated to begin at $15 million per year, ramping up to $60 million per year once it has been demonstrated that this amount of funding can be absorbed in an effective manner. The panel expects that this recommendation will:

- accelerate the trend toward a Canadian culture that prizes excellence in the marketplace and the classroom;
- generate higher demand for enrolment in science, technology, engineering and business education programs; and
- induce more high-achieving students to stay in Canada to pursue their undergraduate degrees.

RECOMMENDATION

Develop and Retain Talent for Success in a Global Marketplace

PROPOSAL

We recommend that the federal government take action to attract skilled and talented individuals to Canada to support commercialization and to link Canadian students, businesses and researchers to global activity that is expanding knowledge.

Create a Talent and Research Fund for International Study

This fund will:

- create a set of Maple Leaf Graduate Scholarships to compete with the prestige of the Fulbright and Rhodes scholarships and attract more of the world's finest minds to this country's campuses;
- bring foreign research and teaching collaborators to Canada to serve as distinguished visiting chairs in disciplines that are strategic priorities for Canada and support its commercialization goals;
- provide matching grants for collaborative research projects with researchers in centres of excellence in other countries;
- support short-term exchanges of researchers between Canadian and foreign universities; and
- significantly increase the number of Canadian students conducting studies and research at foreign universities, thereby gaining exposure to other cultures and markets.

This fund should be administered by the Government of Canada's granting councils.

Encourage International Students to Stay in Canada

Like other countries, Canada should change its immigration policies to make it easier for international students, particularly those in advanced studies, to work while they are studying here and to remain in Canada after graduation. We are pleased to see that pilot projects to address this need have been announced, and look forward to their full availability across Canada. That said, we feel that more aggressive action is required to ensure that international students with advanced degrees from Canadian universities can stay and work in Canada.

REASONS FOR ACTION

As groups such as the Prime Minister's Advisory Council on Science and Technology have noted, Canada has to be open to international opportunities for knowledge creation, sharing and application. This is important across all disciplines relevant to commercialization, including those business-related fields critical to improved corporate management, stronger customer focus and support for innovation.

While we want to see Canada generate more knowledge to enhance commercialization results, Canadians also need to be alert to the knowledge being generated elsewhere. Indeed, some 96 percent of all new ideas and innovations are developed outside of Canada's borders.[15] Canada needs to welcome international partnerships – and the people who make them possible – as a key enabler in reaching its commercialization goals.

The panel believes that addressing the demographic challenges of a declining birth rate is necessary, in part by making Canada a more attractive place for immigrants. We support the government's commitment to bringing down the barriers that prevent skilled immigrants from using their talents fully. However, our commercialization goals for Canada would also benefit from a commitment to an even more open exchange of talent between Canada and other countries.

As part of this, Canada has to make it a priority to attract leading intellectual talent in all relevant areas from around the world. There must be a commitment to opening Canadians' eyes through international study opportunities, and to bringing this global perspective and experience to bear when these Canadians return to Canada. Canada should build on a solid foundation of exchanges and foreign student enrolment in implementing this strategy.

Funding Requirements and Expected Results

Initial funding requirements for this initiative are estimated to be $50 million per year. Pending review by the CPB, this amount could be increased to an estimated $190 million per year, which would provide enough funding to support 500 foreign research and teaching collaborators, 2000 short-term scholarships for Canadian students to study abroad, and more than 2500 scholarships for foreign students to study in Canada. The panel expects that this recommendation will:

- attract greater numbers of outstanding students and scholars to Canadian post-secondary institutions;
- develop more networks of individuals, both in Canada and internationally, who have gained experience through collaborations and exchanges; and
- encourage more international students to stay in Canada after graduation in order to meet demand in fields directly supporting commercialization.

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[15] This figure is based on Canada's share in the world's scientific publications, using Thomson Scientific's National Science Indicators database, 2005.

RESEARCH

Research, whether in the private, public or academic sectors, centres on people investigating questions, experimenting to find solutions and thinking about how to match ideas to opportunities.

The panel strongly supports investments in all forms of research. From a commercialization perspective, the biggest impact of publicly funded research lies in its role in developing talented workers who then apply their knowledge in business settings. This research can also generate ideas that have commercial potential. Indeed, breakthroughs by academic researchers can lead to the creation of whole new industries. For example, Watson and Crick's discovery of the structure of DNA gave birth to the biotechnology industry.

As noted, Canada is making progress on the supply side, particularly through increased support for research at Canadian universities. In fact, OECD data shows that Canada ranks first overall in the G7 in terms of the share of research performed in the academic sector. Most indicators – patenting, licensing income and spinoff companies – also point to improved commercialization outcomes from university research.[16] Budget 2004 provided funding to develop pilot programs aimed at improving commercialization in university and government labs.[17]

One of the major challenges for commercialization in Canada is its relatively low level of business investment in R&D. This lack of demand has been demonstrated in a number of ways, but most importantly in business sector R&D intensity (spending relative to output), in which Canada ranks 15th among OECD countries. Moreover, Canada's R&D-to-GDP ratio is 45 percent below that of the U.S. and 33 percent below the OECD average. Canadian research intensity in sectors commonly seen as high-technology (e.g. computing and telecommunications equipment, pharmaceuticals, etc.) compares favourably with that in the U.S., but these industries account for a smaller share of total economic activity in Canada. Low R&D intensity in other major sectors – including wholesale and retail trade, as well as motor vehicle manufacturing – has a significant impact on Canada's relative standing.

These overall weaknesses have particularly important consequences for the Canadian economy. The OECD estimates that a one-percentage-point rise in private sector R&D intensity could increase per-capita income by as much as 12 percent in the long run.[18]

We recognize there are many potential explanations for the relatively weak state of Canadian private sector investment in R&D, including a lack of competitive pressures, the effects of Canada's tax system on corporate decisions, and the effects of the country's regulatory and intellectual property regimes. We also note that economists cannot fully explain why Canadian businesses do not invest heavily in R&D, despite the generosity of Canada's R&D tax credit.[19]

The panel believes that federal support for key research challenges, matched by private sector funding, would boost private sector R&D activity. This approach would build on Canada's R&D strength in universities, while ensuring that supported R&D is driven by demand considerations. Canada would also draw on the successful experience of other countries in encouraging commercialization in SMEs, while addressing the R&D needs of government. On the supply side, targeted increases in funding for Canadian universities and government labs would promote stronger development of ideas within these settings.

Added investments in research outside of universities must be complemented by continued increases in the public funding of research in Canada's universities and other academic and government research settings.[20]

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[16] For evidence in this regard, see, for example, Association of Universities and Colleges of Canada, *Momentum: The 2005 Report on University Research and Knowledge Transfer* (Ottawa: Association of Universities and Colleges of Canada, 2005) or Cathy Read, *Survey of Intellectual Property Commercialization in the Higher Education Sector, 2003* (Ottawa: Statistics Canada, November 2005).

[17] A collaborative approach was taken to design, and a program proposal has since been developed.

[18] Organisation for Economic Co-operation and Development, *The Sources of Economic Growth in OECD Countries* (Paris: Organisation for Economic Co-operation and Development, March 2003).

[19] More comments on this are available in Section IV as issues for priority attention in the future, and in Appendix E – Historical Context for Innovation and Commercialization in Canada.

[20] See Appendix F – Publicly Funded Research: The Essential Foundation for Excellence in Commercialization.

RECOMMENDATION

Create a Commercialization Superfund to Address Key Commercialization Challenges

PROPOSAL

We recommend that the federal government create a Commercialization Superfund to create commercialization opportunities in industries where Canada has potential competitive advantages. It will do this by:

- supporting large-scale private–public sector research and training partnerships; and
- expanding existing programs, and initiating new ones, to train highly qualified personnel.

The Superfund will:

- focus on fields where Canada is a market leader or can become one;
- address knowledge and/or skill gaps that have been identified by a sector or cluster of firms as critical to meeting future commercialization opportunities;
- attract commitments of private sector funding and engage multiple firms to ensure that skills development and research meet broad industry needs and opportunities;
- locate funded research and training in non-proprietary laboratories (e.g. in federal or provincial/territorial research facilities, universities or facilities jointly operated by different firms in an industry sector or cluster); and
- require collaboration among organizations in several sectors of the economy, including, for example:
  - private or public sector organizations;
  - participants in a supply chain; or
  - organizations in Canada and abroad.

During competitions for this funding, two criteria should be assessed: long-term commercial potential, and the scientific merit and feasibility of the proposals.

Assessment of the long-term commercial potential of proposals should be conducted by a private-sector-led group. Assessments of proposals' scientific merit should be carried out by existing organizations with relevant expertise and experience (e.g. granting councils). Once the organization overseeing this assessment process has determined which projects merit funding, these proposals should be forwarded to the CPB for approval and recommendation to the Minister of Industry, who would have final authority over funding decisions.

REASONS FOR ACTION

Canada's industrial future lies in focused efforts, not small-scale initiatives. However, where to focus has always been a critical challenge for public policy. Under the Superfund, firms and public sector research organizations would commit to medium-term, large-scale projects led by industry. Such a commitment would need to be made prior to any financing from the federal government. In this way, decisions on support would be firmly rooted in demand and be backed by a cross-section of firms and research organizations, significantly improving the chances of success.

Other countries are encouraging private–public research partnerships aimed at delivering results in the marketplace.[21, 22] Their programs often involve the flexibility and adaptability that the panel sees as key to a successful Commercialization Superfund. The fund should supplement existing programs and provide new support to take on emerging challenges. Funding commitments will need to span the 5 to 10 years necessary to develop new knowledge and highly qualified personnel.

Funding Requirements and Expected Results

A pilot program in this area would require funding of about $50 million per year. Pending CPB review of the program's effectiveness and potential demand, funding could rise to $250 million per year. When matched by private sector funding, this could support between 20 and 30 projects at any one time. The panel expects that this recommendation will:

- position Canada as a leading global competitor in selected sectors and economic niches;
- increase the demand for highly skilled people and research in Superfund sectors; and
- improve Canada's capacity to commercialize ideas developed in private sector, university and government research settings, and ensure highly qualified personnel to move them forward.

RECOMMENDATION

Expand Federal Programs that Support Seed and Start-Up Firms in Proving Their Business Ideas

PROPOSAL

We recommend that the federal government increase funding for granting council programs that support private sector research at the proof of concept or proof of principle (POP) stage of commercialization.

The proposed funding must, as a first step, consist of increases to successful programs such as:

- **NSERC's Idea to Innovation program;**
- **the CIHR's Proof of Principle program, which provides grants to advance discoveries and inventions toward technologies that can be commercialized;**
- **the National Research Council Canada's Industrial Research Assistance Program, which supports projects at the pre-commercialization stage, including demonstration and pilot projects; and**
- **SSHRC, to establish a program similar to these three in order to encourage, where applicable, the commercialization of the research it funds.**

Funding must grow based on additional evidence of success in terms of business outcomes and the relevant agency's responsiveness to the needs of these emerging businesses. The CPB should advise the Minister of Industry on funding under this recommendation, which should be based on a competitive process among the granting agencies, involving a strong, peer-reviewed process.

In time, the CPB should decide whether to recommend bringing the individual POP programs together into a single approach.

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[21] See Appendix I – Commercialization Strategies Being Used in Other Countries.

[22] For example, see Organisation for Economic Co-operation and Development, *Public-Private Partnerships for Research and Innovation: An Evaluation of the Australian Experience* (Paris: Organisation for Economic Co-operation and Development, 2004).

REASONS FOR ACTION

Increased funding for research in Canadian universities has led to a growth in spinoff companies, greater licensing of innovations and other commercial benefits.[23]

One of the most critical points for this kind of government action is at the POP stage of commercialization. It is critical that the discoveries emerging from scientific research be brought to a stage where sources of private sector funding, such as angel investors and venture capitalists, can better appreciate their proposed value.

Existing programs provide both financial help and broader assistance to emerging entrepreneurs, thereby helping them develop their business talents. These programs are building track records by helping budding entrepreneurs make the leap to the culture and expectations of the business world. The risk capital community needs to link to these programs so that these projects can gradually progress from government support to support from the private sector at later development stages. Given evidence that start-up firms routinely succeed or fail on the strength of their business skills, Canada needs to do more at this stage.

Funding Requirements and Expected Results

The panel recommends injecting an additional $10 million per year into the programs mentioned, scaling up to $50 million per year following review by the CPB. This would lead to an approximate doubling of financial support in this area. The panel expects that this recommendation will:

- result in more successful commercialization initiatives;
- enhance investor interest in POP-supported initiatives; and
- expand awareness of business and commercialization demands among academic researchers with potential ideas for commercialization.

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[23] For evidence in this regard, see, for example, Association of Universities and Colleges of Canada, *Momentum*, or Cathy Read, *Survey of Intellectual Property Commercialization*.

RECOMMENDATION

Increase the Commercialization Involvement of Small and Medium-Sized Enterprises Through a Canadian SME Partnerships Initiative

PROPOSAL

We recommend that the federal government expand its existing and planned support to SMEs by creating a new Canadian SME Partnerships Initiative to help SMEs become more globally competitive. This support will come through two initiatives: research funding and program support.

Canadian SME Partnerships Initiative – Research Funding

Under this program, federal science-based departments and agencies will compete for five-year funding for research above and beyond their existing budgets.[24] In practice, these departments and agencies will identify topics representing scientific and technical problems requiring innovative solutions (including process innovations). Departmental proposals would be assessed on how well they address public policy priorities, and their potential for future commercial applications. As in other countries with similar initiatives, these programs will often be in fields such as resource management, agriculture, the environment and sustainable development, health, transportation and public security.

Once allocations have been determined through a competitive process, departments would use the incremental funding to support R&D projects carried out by small and medium-sized private sector firms (not academic or public sector research institutions). Funding decisions on individual projects will be left to the individual departments.

Funding for the SMEs will cover two stages:

- feasibility funding, with limited funds for short-term investigation of scientific merit and feasibility; and
- prototype funding, with more extensive funds for the further development of projects with strong scientific and commercial merit (both domestic and global).

After the prototype stage, firms will look to other sources of risk capital to develop their products, services or processes for commercialization.

Canadian SME Partnerships Initiative – Program Support

There is a real need for better support for SMEs engaged in the commercialization of new or substantially improved products, services and processes. This improved support should include efforts to help SMEs reach new international customers, both directly and through international alliances. Federal departments are in the process of examining their efforts in science and technology and in emerging markets. With this work in mind, consideration should be given to significantly expanding support for SMEs through measures such as support for technology acquisition and information gathering, and R&D partnerships with firms and research bodies in other countries. The focus should be on market research and marketing information, guidance and support.

REASONS FOR ACTION

Canada's leading-edge innovation and commercialization often start with small firms created to pursue a specific idea, technology or innovation. These firms could be our multinationals of the future.

Canadian public policy must demonstrate a commitment to helping these firms grow and thrive in the global marketplace. It must also help create linkages between domestic SMEs and larger firms, which often look to much smaller suppliers for specific innovations, thereby providing alliances. Canadian firms can win their share – and more – of these opportunities.

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[24] Such departments and agencies would include Agriculture and Agri-Food Canada, the Canadian Space Agency, Environment Canada, Fisheries and Oceans Canada, Health Canada, National Defence, the National Research Council Canada, Natural Resources Canada and Transport Canada.

The panel recognizes that SMEs often need different kinds of support for their R&D activities to achieve marketplace leadership than do their larger counterparts. With fewer resources to draw on, SMEs require a much broader range of assistance to help develop their business capacities, science, technology and other strengths, and in such critically specialized fields as product design. They need more dedicated access to opportunities in order to gain global knowledge and develop relationships that can lead to growth and further innovation.

To some extent, this is addressed under current programs. The new Canadian SME Partnerships Initiative we are recommending will accelerate the needed action.

The SME Partnerships' research funding program will be similar to what already takes place in very specific areas. A good example is the research on defence-related needs that Defence Research and Development Canada funds. We were also impressed with the experience of the Small Business Innovation Research program in the U.S., which has been very successful in boosting growth and employment in participating SMEs. This success has prompted countries such as the United Kingdom and France to develop similar programs. Another such program is now under development for the European Union.

The Canadian SME Partnerships Initiative will complement other actions recommended by the panel under the Talent and Capital parts of this section. For example, support through the Canada Commercialization Fellowships could help build the talent pool in firms that have received SME Partnerships program support funds as they've moved forward to implement their projects. Success in the SME Partnerships program could also enhance the technical credibility of firms in the eyes of angel and venture capital investors, as it has done in the other countries where similar programs are in place.[25]

For the SME Partnerships' program support funding, we expect program designs demanding the same standards of excellence that we want to see in all programming. The goal has to be working with those companies that are determined to succeed in the global marketplace and are willing to work and take risks to get there.

This focus on risk will mean that many initiatives would fail. However, the panel believes that those that succeed will contribute more than enough to the economy to yield a large net gain from this program.[26]

Funding Requirements and Expected Results

The panel recommends additional funding of $50 million per year for the Initiative, reflecting an increase of roughly 15 percent in the amount of R&D funding that the federal government contracts out to Canadian business. Following a review by the CPB, this funding could increase to an estimated $200 million per year. The panel expects that this recommendation would:

- encourage SMEs to engage in research with long-term commercial potential;
- develop new ideas and address gaps in early-stage funding for promising technologies;
- promote the development of products and services that could help achieve public policy priorities; and
- create stronger links between SMEs and larger businesses.

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[25] Charles W. Wessner, ed., *The Small Business Innovation Research Program: Challenges and Opportunities* (Washington DC: National Academy Press, 1999).

[26] Ibid.

CAPITAL

Capital follows people with great ideas and sound business skills. However, issues of supply and demand are apparent here, as elsewhere in Canada's commercialization system. The consensus among industry experts is that there are financing challenges in two key areas: 1) the seed and start-up phase of a firm's operation; and 2) the expansion phase.

Given that much of the investment for early-stage firms is informal (personal savings, friends, family members and angel investors), there is no definitive evidence in this area. Still, many early-stage firms claim that they face supply gaps. They see a shortage of patient capital at all phases of their development. Current angel, seed and early-stage investors are often not able to provide adequate support, especially for companies that are beginning to grow. Indeed, anecdotal evidence suggests that the Canadian angel investor market is less developed than that in the U.S. and the U.K., with fewer networks and less wealth to reinvest.[27]

In terms of expansion-stage financing, we are concerned by data indicating that the average venture capital investment in a U.S. company is nearly four times that invested in a Canadian company.[28] This underinvestment in Canada may reflect a public policy approach that has focused too much on the quantity of venture capital rather than the quality. Canada needs a venture capital system that works harder at finding investments on which it can place bigger bets. In the panel's view, these smaller investments hamper Canadian firms' ability to expand their operations and compete with their better-funded U.S. competitors. As expansion-stage venture capital financings in Canada often involve syndications with foreign venture capitalists, the panel believes that efforts to promote the flow of foreign capital into Canada are necessary.

The Government of Canada is working to increase the supply of capital for early-stage businesses. For example, the Business Development Bank of Canada recently earmarked $100 million for investment in five new, independent seed and investment commercialization venture capital funds across Canada. Many provinces and territories now have initiatives to marshal venture capital for emerging companies, both directly, from provincial/territorial resources, and by building stronger connections between potential investors and potential investment opportunities.

While this will all certainly help, the key to long-term commercialization success will be in addressing the demand-side problems that investors have identified. These problems include the low returns on investments to date, and the shortage of good proposals backed by strong management teams with track records of success.

We have approached our work from a market-based perspective and believe that measures to improve the quality of demand will eventually earn greater investor activity, and, at the same time, improve capital supply.

Our recommendations on talent should help enhance management and business skills at the firm level. Beyond these, better networking and mentoring at the local level will link people leading seed and early-stage businesses with investors who can help them improve their management and open doors to other investors.

We are less certain of the appropriate role for government in expansion-stage financing. More work needs to be done to understand how government can help in ways that are effective and do not distort markets. Accordingly, we focused on three areas for immediate federal action: improving access to early-stage angel investing and expertise, reviewing expansion-stage venture capital, and removing barriers to foreign venture capital investment.

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[27] See, for example, evidence from Nathaly Riverin, et al., *Global Entrepreneurship Monitor: Canadian National Report 2003* (Montréal: Global Entrepreneurship Monitor Canada, 2005). Led by HEC Montréal and the Sauder School of Business, University of British Columbia.

[28] Data for Canada is from Thomson Macdonald, while U.S. data is from Venture Economics.

RECOMMENDATION

Improve Access to Early-Stage Angel Financing and Expertise

PROPOSAL

We recommend that the federal government support early-stage business development by significantly improving Canada's angel investment environment.

To achieve this goal, we recommend two actions: funding excellence in building angel investor networks, and creating a new angel investor co-investment fund program. Both should be phased in, beginning with a pilot effort. The programs would earn more funding once they have proven their effectiveness.

Funding Excellence in Building Angel Investor Networks

It is necessary to ensure that start-up firms have access to the full range of business acumen necessary to attract early-stage investors.

To develop angel investor networks and enhance the managerial and financial support they provide to early-stage firms, we propose a competitive process to fund non-governmental organizations that mobilize the resources that already exist within communities. These organizations have the knowledge, experience and expertise to foster success. The goal of this initiative is to increase the number of investor-ready firms, improve the quality of the investment opportunities they present to investors, and match them with potential investors. The winning organizations will:

- mobilize people and resources within communities to work with entrepreneurs and emerging company managers to help them become more investor-ready by, for example, providing venues for companies to test their business proposals with informal groups of angel investors, in order to help the companies develop more compelling investment cases;
- match business opportunities with investors;
- strengthen networking activities within local clusters; and
- improve linkages to regional, national and international networks of expertise (i.e. technical, marketing, export and business-related expertise).

A New Angel Investor Co-Investment Fund Program

Early-stage investing is high-risk but essential to a dynamic and prosperous country. To ensure that the community of angel investors continues to grow, investment risk must be shared.

We are proposing the establishment of community-based funds, capitalized by the federal government, which will invest alongside angel investors in seed and start-up companies. Since angel investors will have their own money invested, they will have the incentive to perform all due diligence.

These funds will leverage private investments in start-up companies that are focused on growth through commercialization and will address the need for more funds. The funds will also create incentives for growth and enable angel investor expertise to reach more entrepreneurs and start-up businesses. The funding will expand the scale of angel funds.

The return of investment capital would be structured to reinforce the notion of shared risk but also to be consistent with the commitment to providing funding for early-stage support. Some companies will fail, but those that succeed should generate returns to the economy that exceed the cost of the program.

The interim CPB will need to work with its federal government partners to identify a private sector angel investor body to provide knowledgeable and objective peer review for this recommendation. The CPB should work with expert peer reviewers to identify the proposals from community organizations in both of the recommended action areas, and will recommend these to the Minister of Industry for funding.

REASONS FOR ACTION

Angel investment is about business, not philanthropy, and any advice that angel investors provide or any contributions they make – whether on corporate strategy, alliance and network-building or operational management – are meant to improve their own returns on investment, mitigate their risk and strengthen the companies they support. Their understanding of international markets and opportunities, and their ability to pave the way to later-stage funding, often makes a crucial difference in the progress of the firms in which they invest.

Angel investors are critical to the expansion of existing commercialization clusters and to helping to build local competitive advantages. In the U.S., their importance to start-ups has been demonstrated in many ways:

- Only 2 percent of *Inc.* magazine's 500 fastest growing companies received formal venture capital financing at the early seed stage.[29]
- Three million angel investors in the U.S. invest $50 billion annually in start-ups; their investments reach 30 to 40 times as many companies as formal venture capital investments and involve three to five times more money than comes from formal venture capitalists.
- The University of California at San Diego Connect Project has emphasized angel-type networks as part of a larger strategy that has been credited with helping to create 30 000 local biotechnology jobs and 24 000 jobs in telecommunications.

Information on Canadian angel investments is very limited. Some estimate that there are roughly 50 percent more informal investors per capita in the U.S. than in Canada.[30]

The panel believes that Canada needs to expand the number of people who can bring their money and experience to bear so that the country's commercialization results can be improved. This is a legitimate public policy goal, since angel investors help to shape community attitudes and awareness of the opportunities that come from being innovation- and commercialization-centred. They are a recognized strength of many of Canada's technology clusters, which are known for their innovative businesses. They also help foster the culture of commerce discussed throughout the panel's recommendations concerning talent and research.

Angel investor networks often connect entrepreneurs seeking capital with potential angel investors and can be vehicles for providing advice to entrepreneurs who want to do a better job of meeting investors' expectations. The networks are also important in overcoming two key challenges facing people who could be angel investors: the lack of information about specific investment opportunities and a lack of links to potential partners.

As in all of the panel's proposals, the use of a competitive process will be used, in this case to support angel networks that are strongly motivated to meet the needs of both potential investors and start-up companies that are ready to grow. The panel expects that any program design will draw on lessons learned through previous initiatives, such as the recent Canada Community Investment Plan pilot. We also want to see this program be subject to peer review under the auspices of the CPB.

Funding Requirements and Expected Results

Funding requirements to support a pilot program in this area are an estimated $20 million per year. Based on a review of the program's effectiveness, this could rise to annual funding of $40 million. The panel expects that this recommendation will lead to:

- a significant increase in the number of recognized angel networks in Canada;
- a substantial increase in Canadian angel investment;
- an increase in the number of seed and start-up companies that successfully expand their operations, due to improved business-management capacity and enhanced funding; and
- improved networking among potential partners in commercialization activities across all sectors.

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[29] Based on data from the Canadian Task Force on Early Stage Funding.

[30] Nathaly Riverin, et al., *Global Entrepreneurship Monitor*.

RECOMMENDATION

Review the Expansion-Stage Venture Capital Market in Canada

PROPOSAL

We recommend that the federal government, possibly with provincial/territorial governments' involvement, launch a comprehensive review of policies, programs and other factors influencing the role of the venture capital markets on companies during their expansion stage. This review would involve the venture capital community and include assessing current initiatives and capital supply and demand considerations, including factors for firms seeking financing.

REASONS FOR ACTION

The panel devoted a substantial amount of time to discussing the role of venture capital investments in commercialization opportunities at later stages of business growth but before venture capitalists exit the business. The evidence suggests the following:

- Returns from venture capital in Canada are poor.
- The sector is less mature than its U.S. equivalent (e.g. younger, smaller, with fewer specialized funds).
- Pension funds and other institutional investors have been reluctant to commit capital in view of more profitable opportunities in other fields of private equity investment.

The panel heard from people who believe that high-potential firms will inevitably attract capital, whether Canadian or foreign-sourced. Others say that the likelihood of success increases with financing and the value added from domestic venture capital. The recent Government of Ontario decision to phase out tax credits for investments in labour-sponsored venture capital corporations has focused attention on how the current policy framework affects the Canadian private equity investment environment.

Given the international nature of capital flows today, Canada should ensure that its emerging businesses have access to foreign venture capital (see the next recommendation), and there should be a strong, viable Canadian venture capital industry. The latter was clearly identified as a federal objective in the 2004 federal budget.

The lack of clear information to support explicit recommendations on how best to improve the domestic venture capital environment was a challenge for the panel. Federal and provincial/territorial governments have policies that affect the operation of late-stage capital markets. We did not see the growth from small to medium-sized companies and from medium- to large-sized companies that we wanted. Therefore, a review of the policies and their implications for risk capital markets supporting commercialization is in order.

As well, many other countries face similar questions as Canada does on how best to improve the efficiency and effectiveness of their venture capital markets. These questions include whether to increase investments by pension funds and other institutional investors. A national conference designed to bring together experts who can comment on the experiences of other countries and who can provide information to guide policy choices for stronger venture capital markets will help policy-makers. Such a conference should be preceded by regional conferences that explore the local issues facing venture capitalists and firms seeking investment.

Funding Requirements and Expected Results

The review of expansion-stage financing is expected to cost $1 million (a one-time expense). This review should identify strategies to improve the operation of capital markets and will result in a more effective deployment of available capital. Increased venture capital investment in later-stage companies should also result.

RECOMMENDATION

Remove Barriers to Foreign Venture Capital Investment

PROPOSAL

In line with the conclusions of the Canadian Task Force on Early Stage Funding, we recommend that the federal government:

- eliminate the withholding tax on capital gains made by foreign investors in the equity of private Canadian companies;
- cover limited liability corporations that are venture capital funds or private investment funds under Canada's income tax treaties, and exclude them from withholding tax;
- extend rollover provisions to cross-border mergers, allowing companies to get access to strategic partnerships with foreign companies without triggering taxation; and
- eliminate the requirement that non-Canadian investors file a Canadian income tax return.

REASONS FOR ACTION

While the extensive review process of the previous recommendation would take some time, we believe immediate action can and must be taken to expand Canadian access to foreign venture capital. Foreign investors are increasingly present in the Canadian marketplace, seizing opportunities through syndications with Canadian venture capitalists and other investors. The growth of foreign venture capital financing is such that 27 percent of all venture capital financing in 2005 came from international sources.

To do more, Canada needs to address the barriers arising from current Canadian tax laws, regulations and policies. In this respect, we endorse the recommendations of the Canadian Task Force on Early Stage Funding aimed at improving the flow of foreign money into Canada.[31] This will not only increase the availability of funds for investment but will also increase Canadian talent in venture capital analysis and management that is essential to developing Canada's risk capital marketplace.

Moreover, Canadian companies themselves stand to benefit considerably from venture capital firms' direct links to key suppliers and customers, and from their specialized management and marketing expertise. These benefits will promote the growth of the innovative Canadian companies that Canada needs in order to reach its commercialization goals.

We understand the belief that emerging Canadian companies will be pushed by their foreign investors to move operations to the U.S., or that the investments will lead to foreign buyouts. Our belief, however, is that if the federal government moves promptly on our recommendations, Canada will strengthen its entire commercialization system. This will reduce the attractiveness of other countries to Canada's emerging companies. The real gains will, therefore, be far greater than any potential losses. Canada will be letting the free market work.

Expected Results

Implementation of this recommendation should:

- increase foreign investment in syndications and other funding pools supporting faster growth by Canadian early-stage companies; and
- improve the capacity for venture capital investment in Canada.

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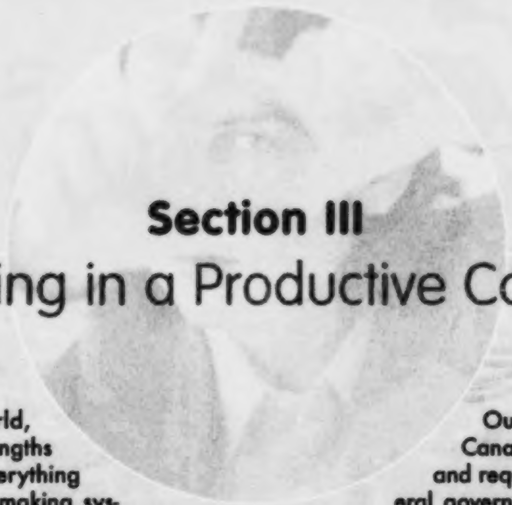
[31] This task force, led by Daniel Muzyka, Dean of the University of British Columbia's Sauder School of Business, and co-sponsored by the National Research Council Canada, delivered its report in December 2004.



Section III

Investing in a Productive Canada

To succeed in today's world, nations must build on their strengths and embed knowledge into everything they do. Many countries are making systematic efforts in this regard by pursuing a focused, national, long-term approach to the commercialization of technology and know-how and to the large-scale investment essential to efforts to increase competitiveness. Canada must do the same.

Our 11 recommendations require Canada to focus its existing efforts, and require a commitment from the federal government to increase its investment by approximately $1.108 billion once the recommendations are fully implemented. Following is a list with each recommendation and a rough estimate of its cost to the federal government. These cost estimates are meant to illustrate the size of the program being recommended, and are not definitive. More definitive estimates will require further analysis.

Commercialization Proposals — Financial Summary (Cost Estimates Only)*

Recommendation	**Estimates of Annual Funding (Pilot Scale)**	**Estimates of Annual Funding (Full Scale)**
Create the Commercialization Partnership Board	$3M	$3M
Talent		
Create the Canada Commercialization Fellowships Program	$65M	$275M
Expand granting council programs to spur hiring of graduates with commercialization skills	$15M	$40M
Encourage and celebrate young Canadians who aim for success in business, science and technology	$15M	$60M
Develop and retain talent for success in a global marketplace	$50M	$190M
Research		
Create the Commercialization Superfund	$50M	$250M
Expand federal programs supporting firms in proof of concept/principle	$10M	$50M
Create the Canadian SME Partnerships Initiative	$50M	$200M
Capital		
Create the community angel networks and angel co-funding program to improve access to early-stage angel financing and expertise	$20M	$40M
Make tax changes to encourage foreign investment	n/a	n/a
Total Annual Funding Requirement	**$278M**	**$1.108B**

*These are investments that the panel believes would bring private sector returns through enhanced productivity but that would still need to be reviewed annually. In addition, approximately $1 million in one-time funding is required to review Canada's expansion-stage venture capital market. The CPB should regularly review the outcomes achieved through these initiatives to ensure that goals are being met. Based on these reviews, the CPB should make recommendations to expand, modify or cancel initiatives as appropriate.

The return on these new investments will include stronger economies at the community, regional and national levels; more demand for highly qualified personnel, especially young people; a more vibrant research climate; and a stronger risk capital community. These represent necessary investments in Canada's future in an extremely competitive world.

We believe that the steps we are recommending, reinforced by the measures discussed in the next section, will help improve the productivity vital to the quality of life of Canadians. They will help to reduce the standard of living divide between Canadians and Americans, estimated at US$8200 (GDP per capita at purchasing power parity).

Finland

The rapid growth of Finland's high-technology economy is often seen as a testament to long-term strategic planning, systematic investment and the ability to adopt innovative policies more quickly than other nations. In the 1970s, Finland's political leaders, research community and labour unions engaged in planning to focus R&D funding in electronics, biotechnology and material technology. Sustained government support paid off, as electronic-based exports grew from 4 percent of Finland's economy in 1980 to 33 percent of all its exports in 2003.[32] Today, Finland's private and public sectors invest 3.5 percent of Finland's GDP into R&D programs (the second-highest level in the world), and the proportion of the country's population working as research scientists is the highest in the world.[33]

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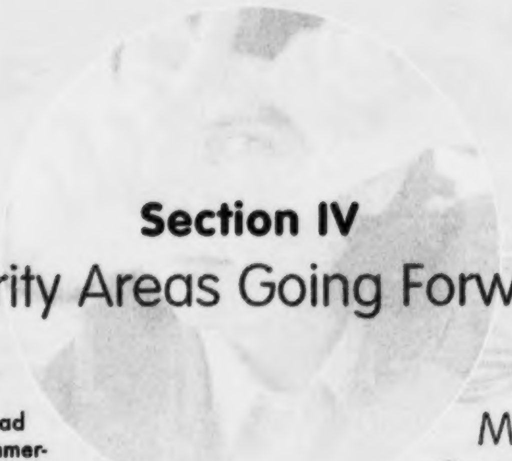
[32] **Organisation for Economic Co-operation and Development, *Innovation Policy and Performance: A Cross-Country Comparison* (Paris: Organisation for Economic Co-operation and Development, June 2005).**

[33] **Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators: 2005/1 edition* (Paris: Organisation for Economic Co-operation and Development, 2005).**



Section IV

Priority Areas Going Forward

This report has presented a road map for action to increase commercialization in Canada. As set out at the beginning of this report, framework policies, competition, taxation, intellectual property and regulation are all instruments that can have a significant impact on demand for commercialization, and further work in these areas is essential. In reviewing these programs, it is critical that Canada address domestic issues with a clear eye on global opportunities – and global competition.

Improvements to Canada's Regulatory System

The External Advisory Committee on Smart Regulation reported in September 2004 on how the federal government could redesign its regulatory system for the 21st century. This work on regulatory reform should help in identifying priorities for action on possible barriers to Canadian commercialization across all sectors of the economy. The CPB should review those recommendations and other regulatory issues that could influence achievement of Canada's commercialization objectives. Possible questions could include the following:

- What approaches to regulation work to maximize incentives to innovate?
- How can Canada's regulatory systems be better aligned with those of its major trading partners in order to open domestic and export doors for Canadian firms?
- Do Canada's financial sector regulatory approaches influence commercialization?

Modernization of Canada's Intellectual Property Laws

Many high-growth sectors rely heavily on intellectual property rights to secure financing and develop their products. This raises questions about the extent to which the *Patent Act* remains supportive of innovation and investment, especially in comparison with intellectual property legislation in other countries. While the federal government has minimal influence over intellectual property regimes in universities, these regimes are also seen as important in encouraging or discouraging commercialization-related research.

There exists a strong body of work on the role of intellectual property regimes on commercialization. In reviewing this field, possible questions could include the following:

- How can Canadian intellectual property protection ensure that firms reap the full benefit of their innovations?
- How can Canada get the most impact from the commercial potential of publicly financed research?
- With new technologies, such as biotechnology, posing challenges for Canada's existing patenting system, is Canada's intellectual property regime keeping pace with advances in technology?
- What steps will ensure competitive international protection for Canadian intellectual property?
- What approach to intellectual property protection for publicly funded research would ensure effective and efficient commercialization?

Improvements to Canada's Tax Regime

A culture of innovation must be supported by an internationally competitive taxation regime. We recognize the steps that the federal and provincial/territorial governments have taken to reduce corporate and personal income taxes. But, even with these reductions, we agree with the C.D. Howe Institute's recent statement that "Canada has the second-highest effective tax rate on capital (taking corporate income and other capital-related taxes into account) out of 36 developed and leading developing competitors."[34]

We also recognize the debate over the effectiveness and possible changes to the scientific research and experimental development (SR&ED) tax credit program.

Possible questions to consider regarding Canada's tax regime could include the following:

- What specific tax measures, such as changes to the SR&ED tax credit, or additional tax credits, would encourage greater investments in commercialization?
- What tax measures would expand access to angel and venture capital investment or stimulate greater protection of companies' intellectual property?
- What tax measures would increase the market research performed by firms?
- Would changes to the capital cost allowance for advanced machinery and equipment have a material impact on Canadian commercialization?
- What are the respective strengths and weaknesses of specific tax approaches in achieving policy goals, compared with using direct program spending?

Increasing Competitive Intensity within the Canadian Marketplace

The panel strongly believes that competition is an important driver of commercialization. A competitive marketplace with capable rivals and sophisticated customers provides incentives for innovation. It encourages the kind of business discipline that leads to stronger Canadian companies that are ready to face international competition. While we have addressed some specific elements of competition in our other business framework comments, we believe the CPB should look at issues such as action under the Agreement on Internal Trade in order to reduce barriers to business activity among provinces/territories, and at measures to improve competition in areas exclusively under federal jurisdiction. Possible questions could include the following:

- What demonstrable effects does the current state of competition in Canada have on innovation and commercialization?
- What steps to improve the competitive environment for business, including steps that may require action by the provinces/territories, would generate the most results through commercialization?

Other Topics

During the course of its work, the panel has identified a number of other issues that also merit attention. These are described in Appendix H – Additional Issues for Longer-Term Consideration.

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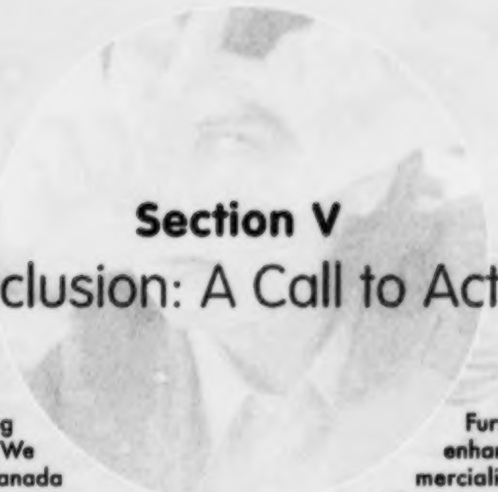
[34] Jack M. Mintz, et al., "The 2005 Tax Competitiveness Report: Unleashing the Canadian Tiger," *C.D. Howe Institute Commentary*, No. 216, September 2005.



Section V

Conclusion: A Call to Action

We began this report by stating that Canada is at a crossroads. We conclude it by stating that Canada must take advantage of the unique opportunity presented by its current economic strength and invest in our ability to transform knowledge into market successes.

Canada needs an approach to policy in support of commercialization that is private-sector-focused and market-driven. This is what will deliver the best results for business while meeting the public interest demands of accountability and transparency. It will produce a more efficient, more integrated system – one that can meet immediate needs, while providing a clear road map for decision making and implementation in the future.

This means changing how we think and act, becoming global leaders and striving for continual improvement.

Canada must become more entrepreneurial. It must accelerate the ability of its innovative and creative thinkers to succeed and be rewarded. It must build on its competitive advantages. And it must do so by focusing on people and excellence.

Further, Canada must refine and enhance how it supports its commercialization and innovation infrastructure. Making it more adaptable and flexible will allow the private sector, governments, academic institutions and other groups to be better able to react to changing conditions, moving aggressively and seizing new opportunities.

It is in Canada's focus and execution that it will differentiate itself from its competitors around the globe.

Finally, Canada must nurture true networks among businesses, government and academia, as well as between the people and institutions that provide the money and expertise that accelerate commercialization: venture capital and institutional investors, pension funds, and angel investors in Canada. It must also nurture networks with the international marketplace in all its dimensions.

All of this will lead to an environment in which highly qualified personnel see and create opportunity and in which demand for innovation is increased. The result will be increased productivity.

To achieve all this, government, business and the education and research communities must work together as never before, united in a common cause to define Canada as an innovative country with products, services and processes that can compete and win in global markets.

People and Excellence:
The Heart of Successful Commercialization

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Introduction

In May 2005, the Minister of Industry appointed a non-partisan Expert Panel on Commercialization to identify how the Government of Canada could help ensure improvement in Canada's short- and long-term commercialization performance. The panel's advice was provided initially in a draft report to Industry Canada on December 16, 2005.

Our final report, published in April 2006, comprises two volumes:

- *People and Excellence: The Heart of Successful Commercialization — Volume I: Final Report of the Expert Panel on Commercialization*; and
- *People and Excellence: The Heart of Successful Commercialization — Volume II: Supporting Material.*

The present volume contains the following 13 appendices:

- the panel's terms of reference;
- principles and values used to evaluate proposed recommendations;
- criteria for assessing new programs to advance commercialization in Canada;
- a conflict of interest statement;
- historical context for innovation and commercialization in Canada;
- an overview of publicly funded research for excellence in commercialization;
- supporting evidence and research on innovation and commercialization;
- a summary of additional issues for longer-term consideration;
- commercialization strategies being used in other countries;
- summaries of points raised in our round-table meetings in several cities across Canada;
- summaries of submissions by numerous stakeholders;
- a list of expert reviewers of draft versions of our final report; and
- a selected bibliography of commercialization.

Further information on all published information used in both volumes of this report is available on request by contacting Industry Canada:

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Appendix A

Terms of Reference

Objective

Commercialization refers to the series of activities undertaken by firms to transform knowledge and technologies (whether developed in Canada or abroad) into new products, processes or services, in response to market opportunities. Highly skilled workers (researchers, engineers, managers, etc.) are critical to the commercialization process, as is a culture that values innovation and entrepreneurship.

Although commercialization is fundamentally a private sector activity, the federal government supports commercialization through measures to improve the business environment, through the provision of direct support to firms, and through its support of efforts to move ideas from universities and government laboratories to use. The Government of Canada recognizes that basic research is critical and that support for this essential activity must continue. In launching the Expert Panel on Commercialization, the federal government is seeking to ensure that its policies and programs in support of commercialization achieve the best possible outcomes for Canadians in all regions of Canada.

Structure

A panel of six Canadians has been named by the Minister of Industry. It is expected that the panel will:

- review reports and proposals from public and private stakeholders;
- hold informal round tables across Canada to obtain informed comment on the panel's preliminary analyses; and
- advise on an action plan to improve commercialization outcomes in Canada.

Timing

The panel is asked to provide its advice to the Minister of Industry in fall 2005.

Areas of Interest

The panel is asked to advise the federal government on how to make a significant contribution to private and public sector commercialization efforts. Three key areas of interest – business environment, support for firms, and publicly funded research – are identified here, but the panel's work is also expected to reflect the strong interrelationships and interdependency among these areas and among the people who work in them. The panel is, therefore, asked to provide advice on how the federal government can proceed with an integrated strategy to bring about the fundamental changes required to improve Canada's commercialization performance over the long term.

Business Environment

Most international reports – e.g., those by the Organisation for Economic Co-operation and Development (OECD), the World Economic Forum (WEF) and IMD – and most domestic assessments – e.g., by The Conference Board of Canada, the Ontario Task Force on Competitiveness, and the Government of Canada – note that Canada's performance with respect to technological innovation and the uptake of leading-edge technologies needs improvement. Although performance and capabilities vary from sector to sector, all reports urge greater technological sophistication. Many factors influence a firm's propensity to use technology (e.g. profitability, exchange rates, personnel, location of markets, etc.), but the business environment created by government is a critical factor. With global supply chains restructuring production, countries that have lower labour costs joining the world's trading system, and product life cycles that are ever shortening with the advance of technology, Canada's business environment must keep pace.

The panel is asked to advise on what changes to the business environment would yield the greatest improvement to the ability of Canadian firms to create new and improved products and services.

Support for Firms

Firms make the decisions that lead to the development of new products and services. Typically, although governments can support such decisions through the provision of a competitive business environment, most of the resources necessary for the development and implementation of new products and services come from the private sector. Although international agreements ensure that direct support falls within strict parameters, all developed countries provide some form of direct assistance to industry for research and/or production.

The panel is asked to advise on how the Government of Canada can improve the design and delivery of its support for firms in their efforts to commercialize ideas.

Canada performs well with respect to new firm formation. However, new knowledge-based firms face unique challenges. Often, their value propositions are not well understood by the risk capital community. Time to profitability for such firms is frequently long, involving many tranches of investment. Pressures to sell out early may be intense, especially when financing can prove difficult. Successful firms need to be "born global," able to compete in world markets from the outset. This requires depth in international commerce. The skills required to create and grow a fledgling technology firm are unique and often difficult to find, and regulatory issues in areas of new technology are often complex.

The panel is asked to advise on how the Government of Canada can enhance the likelihood of success for technology start-ups, for example, by addressing their challenges in securing adequate risk capital, global market expertise and a skilled workforce.

Publicly Funded Research

The conduct of basic research is fundamental to the evolution of a knowledge-based economy. Funding of basic research is a critical role for government and provides a solid foundation for the generation of new ideas – the fuel of a knowledge-based economy. The Government of Canada has invested some $13 billion in new support for research and innovation over the last eight years, increasing Canada's capacity to perform advanced research and helping to train some of the most highly qualified graduates in the world. The research performed and skills imparted are often driven by an internal dynamic of scientific research. However, business decisions are driven by markets and the perceived needs of customers. A more effective interface among the business sector, publicly funded research institutions and government support programs would promote greater transfer of knowledge and skilled people, maximizing the potential for commercial outcomes from public research.

The panel is asked to advise on how the interface between business and public research institutions can be improved to promote more effective transfers of knowledge and skills to the private sector.

Appendix B

Principles and Values

Principles

We, the Expert Panel on Commercialization, decided to adhere to a broad set of principles that we believe will help continue to move the Canadian economy in the right direction. They are as follows:

- The private sector and market forces are the principal drivers of commercialization.
- A strong, internationally competitive foundation in publicly funded research and education that trains highly qualified personnel is a prerequisite for successful commercialization.
- The development and exploitation of knowledge, technology and entrepreneurship provide, both directly and indirectly, the key sources of competitive advantage for growth-oriented firms.
- Partnerships among governments, the private sector and academia – and the formation of networks and clusters – are essential and must be based on trust, respect, cooperation and consistency of purpose.
- An integrated or systemic approach that builds on Canada's strengths is needed to improve Canada's commercialization performance.

Values

We concluded that the advice and recommendations we are submitting had to be impartial and non-partisan; be based on objective, informed discussion; and be geared toward having the broadest possible impact.

Therefore, our recommendations, in order to be effective, had to:

- seek to accelerate commercialization outcomes in the public interest and across a wide range of the economy;
- be honest and independent, and be based on the best evidence and expertise available to the panel;
- be, where possible, the result of deliberations based on sound, evidence-based research and analysis;
- identify and address short-, medium- and long-term issues, and respond to changes with sustainable solutions; and
- reflect the reality of the Canadian economy and the need to be competitive in a rapidly changing global, knowledge-based marketplace.

Taking into account the values and principles that were established, we developed a road map that starts with the here and now and reaches into the future.

Appendix C

Criteria for Assessing New Programs

As members of the Expert Panel on Commercialization, our key objectives were to make recommendations that can be acted on in the short term and to outline other areas and issues that will require a longer time frame for implementation. We also looked for ways to improve commercialization outcomes across a wide range of economic sectors. For these reasons, we asked the following questions when assessing our recommendations:

- Do the recommendations recognize the primary importance of skills and knowledge?
- Do the recommendations focus on promoting excellence?
- Will the recommendations help domestic firms compete globally?
- Will the recommendations strengthen partnerships?
- What is the likely impact of the recommendations?
- Are the recommendations' objectives clear, with measurable results?
- Do the recommendations that relate to new government-spending initiatives represent a legitimate role for government? Are they affordable? Do they offer value for money?
- Are the proposed actions practical, and would the appropriate institutions and stakeholders be able to effectively implement them?
- Have the initiatives been proposed in the past? If so, why have they not been implemented, and how can any challenges be overcome? Is now the right time for action?

These questions enabled us to make practical choices from among the many options for action that were compatible with the principles and values we adopted, and supported by available evidence and analysis.

Appendix D

Conflict of Interest Statement

Given our wide range of active interests in the private sector and academia, panel members requested clarification from Industry Canada on conflict of interest issues. As noted in correspondence from the Expert Panel on Commercialization Secretariat at Industry Canada, the existence or appearance of a conflict of interest can be considered only on a case-by-base basis. *However, the potential for conflicts of interest* within the context of an advisory panel of this nature is limited by two key considerations. First and foremost, the panel serves in an advisory capacity only; the federal government retains authority over any funding or policy decisions that result. Second, conflicts of interest are more likely to arise when individuals are the sole and significant beneficiary of any proposed recommendations. The recommendations outlined in this report are broad in scope and will affect a wide range of parties.

Despite the limited potential for conflict of interest, panel members are subject to the principles set out in Part I of the Government of Canada's *Conflict of Interest and Post-Employment Code for Public Office Holders* as part-time appointees working on a voluntary basis on behalf of the Minister of Industry. Within the context of the panel, some of the most relevant principles are as follows:

- Ethical standards: Act with honesty and uphold the highest ethical standards to conserve and enhance public confidence and trust in the integrity, objectivity and impartiality of government.
- Public scrutiny: Perform official duties and arrange private affairs in a manner that will bear the closest public scrutiny (an obligation not fully discharged by simply acting within the law).
- Decision making: Make decisions in the public interest and with regard to the merits of each case.
- Private interests: Have no private interests, other than those permitted under the Code, that would be affected particularly or significantly by government actions in which panel members participate.
- Public interest: Arrange private affairs in a manner that will prevent real, potential or apparent conflicts of interest from arising. Should a conflict arise, it is to be resolved in favour of the public interest.
- Insider information: Do not knowingly take advantage of or benefit from information that is obtained in the course of official duties and responsibilities and is not generally available to the public.
- Fundraising: Do not personally solicit funds from any person, group, organization or corporation where such fundraising could place public office holders in a position of obligation that is incompatible with their public duties.

As panel members, we are aware of our responsibilities in the area of conflict of interest, and are confident that we have acted with the highest ethical standards, with the public interest our foremost consideration. On the few instances where potential conflict of interest arose, panel members identified the conflict and did not participate in deliberations.

A related issue is lobbyist registration. Advice received from the Expert Panel on Commercialization Secretariat at Industry Canada indicated that there was no expectation that panel members would be required to register as lobbyists by virtue of their membership in the panel.

Appendix E

Historical Context for Innovation and Commercialization in Canada

A Brief History of Federal Innovation Policy[1]

The federal government has recognized the importance of innovation to Canada's economy since shortly after Confederation. For example, support for agricultural research was designed to meet the needs of a rural-based economy with a strong export orientation. Also, the creation of the National Research Council Canada in 1916 was designed to ensure a consistent structure to support research. As well, defence research beginning in World War II was routinely focused on responses to military needs, including those that could find markets in other countries.

The federal government's policy commitment to innovation began substantively in the 1970s in response to research showing that technological progress was a key determinant of economic prosperity and growth in per-capita income.[2]

The 1970s

The 1970 report of the Senate Special Committee on Science Policy (the Lamontagne report), was one of the first Canadian reports to identify innovation as a key driver of economic and social well-being. The report called for sectoral science policies and an overall science policy to encourage industrial innovation and address social issues.

In response to this report, the federal government created the position of Minister of State for Science and Technology in 1971, endowing it with responsibility for formulating policy and coordinating activity in this area. The Government of Canada also established the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada. Prior to this, university-based research had been supported only through the National Research Council Canada.

Federal programming began to focus on supporting commercialization, through expanded regional and industrial initiatives, including the Program for the Advancement of Industrial Technology and the Defence Industry Productivity Program.

The 1980s

The most influential study in the 1980s was the Royal Commission on the Economic Union and Development Prospects of Canada (the Macdonald Commission). It sponsored extensive studies, from health and education to trade liberalization and the reform of economic regulations. Most famous for providing the impetus for the Canada–U.S. Free Trade Agreement, the Macdonald Commission also set out the broader challenges for developing a knowledge-based economy within a global context.

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[1] This section draws heavily from a report prepared by Val Traversy for the Prime Minister's Advisory Council on Science and Technology, entitled "Commercial Innovation: A Policy Stocktaking" (Ottawa: Industry Canada, June 2003).

[2] Nobel Prize–winning economist Robert Solow observed that growth in per-capita incomes is largely explained by technological progress, manifested through increases in either knowledge or capital investment (i.e. embodied knowledge). This concept was reinforced by the emergence of "new growth theory" in the 1990s, championed by, among others, Paul Romer and Richard Lipsey, who developed endogenous growth models incorporating innovation as the principal way of adding value beyond increases in materials, labour and capital.

Work done in the 1980s by the Science Council of Canada – created in 1966 to undertake background studies on science and technology (S&T) – focused attention on improving the interface between universities and industry. In 1987, the National Advisory Board on Science and Technology (NABST), with members drawn from academia, business and labour, was created to advise the prime minister on policy priorities in S&T. The next year, Industry, Science and Technology Canada was formed by merging the Department of Regional Industrial Expansion with the Ministry of State for Science and Technology. The new organization's mandate was to improve the ability of Canadian industry to compete internationally and to excel in S&T.

The 1990s

The federal Prosperity Initiative was established in the early 1990s to address Canada's weak innovation capacity, which was resulting in a widening productivity gap between Canada and key competing nations. Weak levels of investment in machinery and equipment, low public and private spending on research and development (R&D), and a comparatively poor record in employee training were seen as some of the factors needing action. The Prosperity Action Plan focused on the need to increase funding for R&D and infrastructure, improve the investment climate and address marketplace issues, and emphasized the role of skills and education in economic growth.

In 1994, a restructured Industry Canada released *Agenda: Jobs and Growth – Building a More Innovative Economy*. The report focused on supporting growth through innovation and trade. It stressed the need for a higher return on investments in S&T, better commercialization results from federal science, and measures to increase the dissemination of technical knowledge to industry.

Following an earlier statement on competitiveness, which highlighted Canada's failure to effectively use S&T, NABST released *Healthy, Wealthy and Wise: A Framework for an Integrated Federal Science and Technology Strategy* in 1995. The report called for improving the coordination of government S&T activities, encouraging innovation through incentives, reviewing the tax structure, and supporting new companies and entrepreneurs. The report also recognized the need to attract talent, given the increasing mobility of skilled workers and the greater clustering of knowledge-based activities.

At the same time, organizations such as The Conference Board of Canada and the Organisation for Economic Co-operation and Development (OECD) were also studying innovation. OECD analysis of global trends, coupled with detailed, cross-country comparisons documenting Canada's sizeable innovation gap, played an important role in highlighting the key challenges for Canada.

Part of the federal government's response was the *Science and Technology for the New Century* report in 1996. The report triggered the creation of Technology Partnerships Canada, which would invest up to 30 percent of the cost of R&D or demonstration projects, mainly in the aerospace and defence industries, with a smaller fund for other types of technologies. Under the new strategy, NABST was replaced by the Prime Minister's Advisory Council on Science and Technology, an external advisory body reporting directly to Cabinet. The Advisory Council's mandate was to review Canada's performance in research and innovation, identify emerging issues of national concern, and advise on an agenda to help position Canada for international success. The Advisory Council has played an important role in shaping innovation and commercialization policy since then, and has produced reports on skills, university research and international S&T.

The New Century

In February 2002 the Government of Canada launched an innovation strategy based on two key documents: *Achieving Excellence: Investing in People, Knowledge and Opportunity*, which focused on the role of innovation in the economy, and *Knowledge Matters: Skills and Learning for Canadians*, which was centred on skills, labour and immigration. *Achieving Excellence* recommended improving Canada's innovation performance by addressing four key challenges: knowledge creation and commercialization, skills development, the innovation environment, and strengthening communities. To ensure Canadians would have the tools they needed to participate in the workplace, *Knowledge Matters* outlined goals for children and youth, post-secondary education, the adult labour force and immigration.

In the 10 months following the release of the two papers, an ambitious range of engagement activities was held, involving more than 10 000 Canadians. It culminated in the National Summit on Innovation and Learning in November 2002, bringing together more than 500 leaders from across the country to develop priorities for action to make Canada one of the most innovative and skilled countries in the world (see innovation.gc.ca/gol/innovation/site.nsf/en/in04113.html).

Current Programming Supporting Private Sector Commercialization

In spring 2004 Industry Canada built a database of federal programs that support commercialization activities, identifying roughly 100 such programs managed by federal departments or agencies. Although there were some major limitations in developing the database, some clear findings did emerge.

The Scientific Research and Experimental Development (SR&ED) tax incentive program is the Government of Canada's largest single funding program supporting business activity, with a total projected tax expenditure of $2.5 billion for 2005. With many provinces also providing similar tax credits, Canada's tax treatment of R&D expenses is considered to be one of the most generous in the world.[3] However, some analysts have noted that not all companies can access these tax credits at critical times (for example, publicly traded companies that are not recording profits). In addition, although Canada may have generous tax credits, other forms of support lag behind those offered in other countries. For example, direct government funding of business expenditure on R&D represents 0.03 percent of gross domestic product (GDP) in Canada, compared with 0.18 percent in the United States and the average of 0.11 percent for OECD countries.[4]

Some 25 federal Canadian departments or agencies manage programs that support commercialization in one form or another. Industry Canada and members of the Industry Portfolio manage the largest number of these programs. Key forms of support from such programs include grants and repayable contributions for applied R&D projects (most often geared toward small and medium-sized enterprises [SMEs]), whether through programs that have a broad reach, such as the Industrial Research Assistance Program (IRAP), or through sector- or technology-specific programs, such as Sustainable Development Technology Canada. The federal government supports access to specialized research facilities and sources of financing, and provides general business counselling services and information on market intelligence and technology acquisition.

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3. Information on projected tax expenditures for the SR&ED tax credit has been taken from *Tax Expenditures and Evaluations 2005* (Ottawa: Department of Finance Canada, 2005). For international comparisons of R&D tax credits, see *Extending Access to SR&ED Tax Credits: An International Comparative Analysis* by Jacek Warda, JWInnovation Associates Inc. Sponsored by Ernst & Young, IBM, PricewaterhouseCoopers LLP and Research In Motion (Toronto: Information Technology Association of Canada, December 2003).
4. Based on OECD data for 2003.

An analysis by The Impact Group done on behalf of the Expert Panel on Commercialization concluded that there was little consistency or cohesion in the suite of programming offered by the federal government. The Impact Group pointed out that programs appear to operate in isolation from one another and, although some programs have rather limited budgets, there are some with substantial resources.[5] The panel has identified a review of the government's suite of programming as an area the proposed Commercialization Partnership Board may wish to examine further.

Commercialization

Many people think of commercialization as the final stage of a neat, linear process of innovation. They think in terms of someone with an idea in a laboratory, and imagine that, step by step, that idea matures into a product, service or process that enters the marketplace. This view of commercialization is focused on the science, technology and research behind innovation.

Our panel has taken a broader view, based on our experiences with business realities.

Commercialization is a complex, integrated system anchored in the world of business. It has many components that come together in different ways. Each commercialization situation is different and based on a distinct mix of factors, including:

- supply-and-demand issues, such as the pull of needs and wants in the marketplace and the push of innovative ideas emerging from research laboratories;
- business operation factors, such as:
  - firms' financial, operational and human resource strengths, in addition to their research and innovation strengths;
  - openness to a global exchange of talent, research and capital;
  - recognition that trial and error, risk and failure are as much parts of the entrepreneurial climate as success and that the path to success is long and full of dead ends and wrong turns; and
  - the drive of individual businesses that see improved competitiveness, innovation and customer focus as keys to success;
- marketplace framework issues, including:
  - strong, effectively funded education and publicly funded research systems that generate knowledge and skilled people who know how to create, build on and apply this knowledge;
  - the mix of laws, government policies, intellectual property, regulatory and tax regimes, programs, and supports; and
  - capital markets and other forms of financial support that facilitate access to funding for commercialization; and
- issues that affect all of the preceding, such as the quality of information and its flows for decision making, and the presence of alliances, networks and other forms of connection among business, governments, educational institutions and other partners.

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[5] The Impact Group, "Commercialization Activities of the Federal Government: Program Synopsis" (Toronto: July 2005). A small number of programs (less than one fifth of the total) were responsible for more than three quarters of the overall spending in this area.

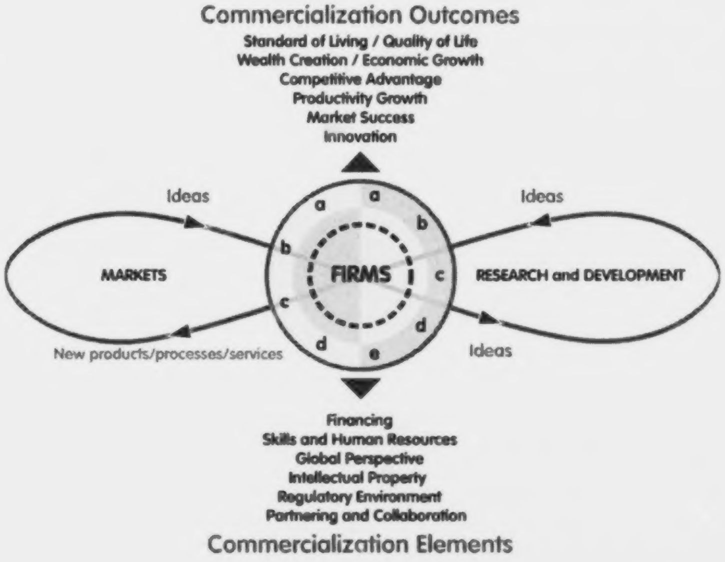
Commercialization is not a one-size-fits-all process. The nature and relative importance of the factors listed in the preceding vary considerably among a small, Canadian information technology start-up firm, an established pharmaceutical company and the Canadian operations of a large, multinational mining or insurance corporation. However, no matter the situation, two pivotal elements are at the heart of this complex commercialization system for all firms and for all countries – people and excellence:

- People identify market opportunities, carry out research, make investment choices, build networks with other people, create businesses that function well, and are the ultimate customers. All of these are essential to commercialization.
- Excellence is demonstrated when people conduct the highest-quality research possible, develop and attract the full range of skills needed for successful commercialization, create compelling cases to attract the investment needed to support commercialization opportunities, and identify and act on the needs of customers and of partners in the supply chain that bring products and services to market.

Both of these elements are woven throughout the following model of commercialization in the economy (see Figure 1). This model was developed by the federal government's Interdepartmental Working Group on Commercialization.

Figure 1

Commercialization in the Economy


Commercialization Outcomes
Standard of Living / Quality of Life
Wealth Creation / Economic Growth
Competitive Advantage
Productivity Growth
Market Success
Innovation
Ideas
Ideas
MARKETS
FIRMS
RESEARCH and DEVELOPMENT
a
a
b
b
c
c
d
d
e
New products/processes/services
Ideas
Financing
Skills and Human Resources
Global Perspective
Intellectual Property
Regulatory Environment
Partnering and Collaboration
Commercialization Elements

FIRMS' focus
Firm Strategy and Leadership

Commercial Functions
a Operations
b Marketing/Promotion
c Distribution/Sales
d Customer Feedback

Technology Development
a Research
b Development
c Proof of Concept
d Prototype
e Research Planning

The Benefits of Commercialization for Canadians

With Canada doing well according to most broad measures of economic success, some may ask why commercialization needs to be a particular priority for Canada's governments and businesses alike. Why accelerate the commitment to commercialization that is already evident in many parts of our economy?

Many traditional routes to increasing living standards are closing for Canada. The country's population is aging; growth in the labour force is slowing, and the average Canadian worker is already working about as many hours as possible. Canada has to do better than ranking 27th in the world in its propensity to compete on the basis of unique products or processes instead of low-cost labour or raw materials.[6] A strong focus on commercializing products, services and processes will give Canada more sales at home and around the world, due to the productivity of highly skilled jobs and leading-edge industries. It will take Canada's economy beyond the country's traditional strengths in natural resources, and will create an approach to gaining international business that is more lasting than relying on low costs that reflect exchange-rate factors.

For workers, commercialization and a focus on improved productivity usually reflect features that make for a better workplace. Firms that are particularly active in commercializing new ideas have broader cultures of innovation. Such firms:

- seek out the ideas and contributions of people throughout their operations, including leaders, sales and customer service people, technical experts, and front-line staff;
- are more likely than most to be export-oriented;
- tend to invest more in training their employees;
- tend to invest more in machinery and equipment; and
- are more customer-driven.[7]

Canadians need to receive more of the benefits of the increased productivity linked to commercialization. Canadians need the high-quality jobs and the improvements to all jobs that commercialization can bring about. For Canada, improved productivity means an improved quality of life for all Canadians. Innovative firms that are active in commercialization and in using new technologies and ideas are at the heart of strong economic activity in Canada. They generate the taxes that support Canada's health care system, they invest in Canadian communities, and they reinforce the strengths of Canada's education system.

These factors make it imperative for Canada to focus on the ways that each worker can produce more, including developing and using the new technologies that are reshaping how goods are produced and services are provided. This will mean more Canadian workers doing jobs that call on the highest levels of skills possible.

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6. World Economic Forum, *The Global Competitiveness Report 2005–2006* (Davos: World Economic Forum, 2005).

7. These statements are supported by findings from Statistics Canada's *Survey of Innovation* (Ottawa: Statistics Canada, various years).

Commercialization in Canada: A Solid Base — With Substantial Room for Improvement

By definition, reports such as this focus on the work that needs to be done. There are many questions that underline Canada's weaknesses in the world of innovation and commercialization that should be asked, including:

- Why do so many innovative small and start-up firms fail to survive and expand?
- Why do so many Canadians still leave this country to build careers in the U.S. and elsewhere?
- Why do investors say there is a lack of good investment opportunities related to commercialization, while emerging companies say they cannot attract the funding they need to move forward?
- What factors explain why large parts of the Canadian economy feature relatively little homegrown innovation and commercialization?

These questions are put into sharper definition when we look at some specific gaps and challenges for Canada:

- Data from the OECD shows that Canada has a smaller share of high-technology industries that tend to be R&D intensive than do its competitors. In 2001, high-technology manufacturing industries accounted for 1.5 percent of Canada's GDP, compared with 2.8 percent for the U.S. and 3.1 percent for Japan.[8]
- The share of high-technology industries in manufacturing exports is significantly lower in Canada than in all other G7 countries except Italy.
- According to survey results from the World Economic Forum's annual *Executive Opinion Survey*, Canada also lags behind in improving entrepreneurship and productivity in company operations and strategies.
- When compared with the U.S. and many OECD countries on an employee basis, Canadian firms lag well behind in the level of patenting activity, even after controlling for sector composition.[9] For example, a 2004 study by the OECD showed that there are 17 triadic patent families per million population in Canada, compared with 70 in Germany and 53 in the U.S.[10]
- Private sector investment in information and communications technologies in particular, and machinery and equipment more generally, is weak by international standards. The C.D. Howe Institute estimates that Canadian businesses invest $1000 less per worker compared with the OECD average, and $2000 less per worker than firms in the U.S.[11] Low investment levels translate directly into lower productivity and, ultimately, a lower standard of living in Canada.
- European firms derive a higher proportion of total sales from recent innovations. Sales from new or improved products accounted for 35 percent of all sales by Canadian firms with Canada-first or world-first innovations, compared with 54 percent in Germany.[12]

Many possible explanations have been proposed to account for these commercialization deficits. These include Canada's industrial structure, its high degree of foreign ownership, its high proportion of small and medium-sized businesses, and the importance of its resource base in its economy. Other explanations have focused on the macroeconomic environment, most notably the general framework policies put in place by governments to facilitate commerce. Some emphasize the impact of Canada's position as a small, open economy on incentives to innovate.

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[8] Organisation for Economic Co-operation and Development, *OECD Science, Technology and Industry Scoreboard 2005* (Paris: Organisation for Economic Co-operation and Development, October 2005). High-technology industries include aerospace technology; pharmaceuticals; office, accounting and computing machinery; radio, television and communications equipment; and medical, precision and optical instruments.

[9] See Roger L. Martin, *Realizing Canada's Prosperity Potential* (Toronto: Institute for Competitiveness and Prosperity, January 2005).

[10] Organisation for Economic Co-operation and Development, *Compendium of Patent Statistics 2004* (Paris: Organisation for Economic Co-operation and Development, 2004). Triadic patent families are defined as a set of patents held at the European, U.S. and Japanese patent offices to protect the same invention. According to the OECD, this indicator provides an improved picture of innovative activity at an international level.

[11] Danielle Goldfarb and William Robson, "Canadian Workers Need the Tools to Do the Job and Keep Pace in the Global Investment Race," *C.D. Howe Institute e-brief* (May 5, 2005).

[12] Pierre Mohnen and Pierre Therrien, "How Innovative are Canadian Firms Compared to Some European Firms? A Comparative Look at Innovation Surveys," *MERIT-Infonomics Research Memorandum* series, 2001-033 (July 2001).

The panel chose to look at commercialization from the perspective of business organizations where commercialization activities actually take place. From this perspective, the panel noted three key aspects in which Canadian businesses tend to differ from firms in countries that have better commercialization outcomes:

- the availability within firms of highly skilled and talented individuals who can take ideas and convert them to market-ready products and services;
- the extent to which Canadian firms carry out research, thereby building within the company an ability to both produce ideas and adopt or adapt the ideas of others to the needs of the firm; and
- key challenges facing companies in the Canadian market for risk capital, including inexperience within smaller firms in the skills needed to make the case for investment, and a series of important structural differences between Canada and the U.S. in the sources of risk capital and the way it is invested.

Research by organizations such as the OECD, a leader in comparative studies on innovation across major industrialized countries, indicates that addressing challenges in these three areas will help boost Canada's commercialization outcomes. These factors are discussed in more depth in Appendix G — Supporting Evidence.

Even with these factors, Canada is well positioned for future success. Canada's past economic performance provides it with a strong base for future progress, and many of the elements are in place to improve the private sector's commercialization performance. With the addition of the proposals found in this report, the panel believes that Canada's commercialization future will be bright.

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Appendix F

Publicly Funded Research: The Essential Foundation for Excellence in Commercialization

The recommendations in this report are based on one key premise: continuing government commitment to publicly funded research carried out with little or no expectation of commercial application.

Panel members know that good research does not necessarily translate directly into economic growth. Our view is that:

- Publicly funded research across all disciplines is essential and must be funded at internationally competitive levels, along with the institutions and infrastructure that provide the capacity to conduct this research.
- These investments must be viewed as building capacity in Canada to train people and deepen understanding, not as engines of growth in and of themselves.

Some believe that government funding aimed at improving Canada's commercialization performance should come at the expense of support for publicly funded research. This is both wrong and destructive to Canada's commercialization goals.

We underline this point because, as noted earlier, successful commercialization outcomes depend on the larger process of innovation in a country. Canada cannot build a more robust commercialization environment without a strong research community committed to excellence in the pursuit and use of knowledge.

How are publicly funded research and commercialization linked? As in all other parts of the commercialization equation, it comes down to people. The men and women undertaking leading-edge research in universities and public research organizations are the nuclei of the communities of creation and clusters of innovation. By focusing on excellence and generating advanced and exciting insights, these researchers attract students and colleagues of the highest calibre.

Therefore, while publicly funded researchers may never be involved directly in commercialization, their students and colleagues can draw on their work when developing new products, services and processes. Innovative businesses will locate and be created in these communities because of the excellence of the people within these communities and the excellence of their ideas – all of which have their roots in publicly funded research.

Moreover, no one can predict which lines of research effort will generate major, dramatic advances. Valuable research that expands and transforms our understanding – and that may later pave the way for new products, services and processes – is generated in all disciplines, not just the sciences, technology and engineering.

A commitment to global leadership in research and the use of knowledge has to be sustained over the long term. Without this, Canada will not have the base needed to develop and attract talent and to spark research ideas with commercial potential. In turn, these two elements provide a powerful attraction for entrepreneurs, knowledgeable investors and risk capital.

Appendix G
Supporting Evidence

Introduction

Commercialization activities are firmly anchored in the world of business. That is why the panel chose to examine Canada's commercialization challenges from the perspective of the firm. There are many different views on why Canadian firms tend to lag behind their competitors in other countries in commercialization, and these views can be backed up by empirical evidence to varying degrees.

Our deliberations have been supported by the considerable amount of research that has been conducted on innovation and commercialization, both within Canada and internationally. Appendix M comprises a selected bibliography of some of the most important research. We have also benefited from the valuable insights gained from stakeholder submissions and by a series of informal executive round tables that we conducted. Information on all the published information used is available on request by contacting Industry Canada.

Based on a review of the material, and our best judgment, we chose to focus on three key areas in which the evidence shows that Canadian businesses tend to differ markedly from firms in countries that have better commercialization outcomes:

- **Talent** – the availability of highly skilled and talented individuals within firms;
- **Research** – the extent to which Canadian firms carry out research; and
- **Capital** – the key financing challenges that innovative companies face.

Extensive research by organizations such as the Organisation for Economic Co-operation and Development (OECD) supports our position that action in these three areas is crucial to improving Canada's commercialization performance. The relevance of these three themes has also been confirmed through input received from the executive round tables and stakeholder submissions.

An important issue is the extent to which Canada addresses the supply or demand side of the commercialization equation. We believe that Canada has made significant progress on the supply side, although continued efforts to renew and expand supply-side measures are required. There is clear evidence, however, that Canada lags behind other countries in terms of the demand for commercialization (or the pull from the market). For this reason, we argue that focused efforts on the demand side are necessary. In our judgment, these can be achieved by reducing barriers and perceived risks that firms face in the three key areas outlined above. Actions that bridge or link supply considerations to increasing demand at the firm level are likely to be particularly effective in promoting the development of a business culture that values innovation and supports better commercialization outcomes.

Improving the Business Climate

As noted in Section I of Volume I of our report, a healthy business environment is an important precondition for successful commercialization. Supportive macroeconomic conditions and general framework policies that promote innovation and reward success are important elements of a sound commercialization system. Much has been written, both inside and outside government, on how these conditions can be improved to encourage firms' commercialization efforts. For example:

- In a series of insightful articles, the C.D. Howe Institute has made a compelling case for lower corporate tax rates.
- The Government of Canada's External Advisory Committee on Smart Regulation has provided advice on how the regulatory system can be reformed to better protect the health and safety of Canadians and the environment while supporting an innovative and dynamic economy.
- The OECD Growth Project has provided empirical support that demonstrates the importance of solid macroeconomic fundamentals for economic growth.[1]

We believe that it is critical that Canada maintain efforts to improve the country's underlying business environment, and we have identified such efforts as important issues for further analysis by the proposed Commercialization Partnership Board. Given our tight deadline for reporting, and the extensive body of existing and ongoing work, we saw little benefit in commenting in detail in these areas.

Talent:

A Key Determinant of Productivity, Growth, Innovation and Commercialization

The OECD considers talent to be one of the key drivers of the development and use of new technologies in an economy.

> The role of human capital as a central pillar of the development process is not new. There is a well-established relationship between human capital, understood as the skills and competencies embodied in workers, and labour productivity – and it is not surprising that improvements in one should lead to increases in the other. Consequently, as empirical studies have found, human capital is a significant determinant of economic growth.[2]
>
> There is, however, renewed interest in the productivity-enhancing role of human capital. One reason is its complementarity with new technology: for [information and communications technologies] to be developed and used effectively, and network externalities of new technology to materialise, the right skills and competencies must be in place. One of the factors behind the good growth record of some countries has been the availability of a large pool of qualified personnel. And skilled labour shortages are rightly considered as a constraint to the growth process.
>
> – Organisation for Economic Co-operation and Development,
> *The New Economy: Beyond the Hype – The OECD Growth Project*
> (Paris: Organisation for Economic Co-operation and Development, 2001), p. 55.

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[1] See, for example, Peter J. Nicholson, "The Growth Story: Canada's Long-Run Economic Performance and Prospects," *International Productivity Monitor* 7, 3 (Fall 2003): pp. 3–23.

[2] For example, Andrea Bassanini and Stefano Scarpetta found that one additional year of schooling would, on average, lead to about a 6-percent increase in GDP in the long run. See *Does Human Capital Matter for Growth in OECD Countries? Evidence from Pooled Mean-Group Estimates*, OECD Economics Department Working Paper No. 282 (Paris: Organisation for Economic Co-operation and Development, January 2001).

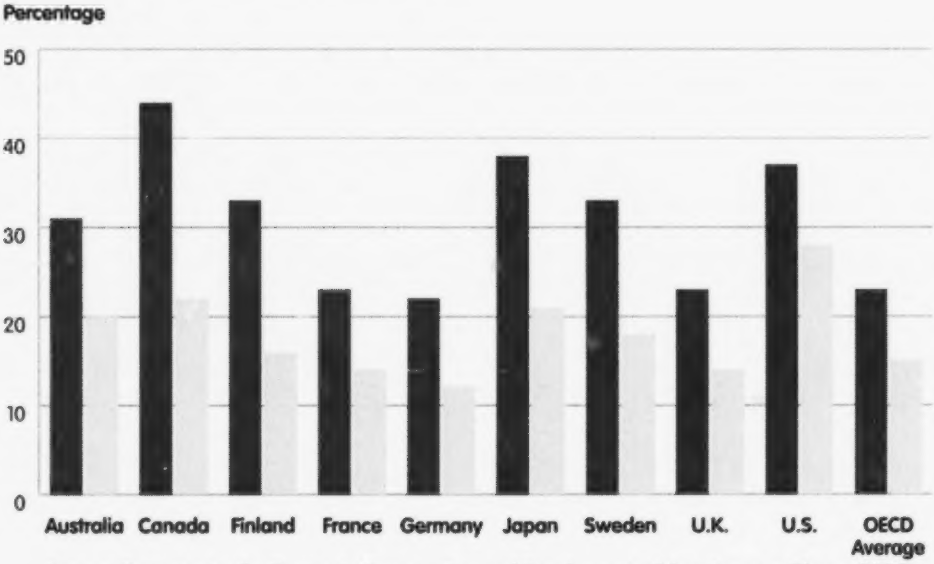
Supply Considerations

Post-Secondary Attainment

OECD data shows that, among all G7 countries, Canada has the highest proportion of post-secondary graduates in the workforce. However, Canada does not rank as highly in terms of more advanced degrees. In particular, Canada lags behind the U.S. in terms of the share of university graduates in the total workforce. While 22 percent of the Canadian labour force has a university education, the comparable figure in the U.S. is 28 percent (see Figure 2). This gap is particularly high at the PhD level. In 2001, Canada had 429 persons with PhDs per 100 000 people, compared with 755 in the U.S.

Figure 2

Distribution of Labour Force by Level of Education, 2003



■ Post-Secondary

□ University

Source: Organisation for Economic Co-operation and Development, *Education at a Glance 2005.*

Post-Secondary Enrolment

Statistics Canada data indicates that full-time enrolment at Canadian universities rose 28 percent from 1997–98 to 2003–04.[3] Although some of this overall increase can be attributed to the impact of the Ontario double cohort that was due to the elimination of Grade 13 Ontario Academic Credit courses, the proportion of young adults entering university has nonetheless increased over time. Among the largest proportional gains in enrolment from 1997–98 to 2003–04 were a 37-percent increase for business, management and public administration (which has led growth since 1999), and a 37-percent increase for architecture, engineering and related technologies. Enrolment in mathematics and computer and information sciences was up 27 percent compared with 1997–98, even after recording a modest 3.2-percent year-over-year decline in 2003–04.

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[3] See the October 11, 2005, issue of Statistics Canada's *The Daily* (www.statcan.ca/english/dai-quo).

Enrolment at the PhD level has increased by 18.5 percent since 1997–98, and includes strong gains in engineering and physical and life sciences. There was a 28-percent increase in enrolment for master's students over the same period.

About 70 000 foreign students were registered in Canadian universities in 2003–04, accounting for 7 percent of total enrolment. This share is up from 4 percent 10 years ago.

Post-Secondary Graduation

Reflecting the data on rising enrolment, the number of university graduates in Canada has increased immensely in recent years. A record number of undergraduate and master's degrees were awarded in 2003. Undergraduate degrees were up 9.7 percent compared with 1996 levels, while the number of master's degrees increased by 34.6 percent.[4]

The number of earned doctorates, up 3.5 percent from 2002 to 2003, was nonetheless slightly below the number awarded in 1996. Comparisons of PhD graduation rates among OECD countries are cause for concern, with Canada ranking sixth in the G7 in terms of new PhDs awarded per capita in 2000. This suggests that the Canada–U.S. gap in the supply of PhDs is not closing.

In terms of graduation rates by field, the business, management and administration field accounted for 21 percent of all university degrees, certificates and diplomas in 2003. Looking at growth trends from 1996 to 2003, the total number of degrees awarded in all fields increased in Canada by slightly more than 13 percent. Major increases were recorded in business, management and public administration (up 41 percent); mathematics, computer and information sciences (up 50 percent); and architecture, engineering and related technologies (up 30 percent).

Funding for Post-Secondary Education

As shown in the Research section of this appendix, which outlines key evidence relating to Canadian research activities, Canada's funding for post-secondary research is internationally competitive. However, there is serious concern that the total funding available to Canadian universities lags behind that of major competing countries. The Association of Universities and Colleges of Canada (AUCC) estimates that U.S. universities and four-year colleges have 50 percent more government funding per student for teaching and research than do Canadian universities.[5] The AUCC attributes this funding gap to higher U.S. government funding, but also to higher tuition fees paid by American students.

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[4] Ibid.

[5] Association of Universities and Colleges of Canada, *Momentum: The 2005 Report on University Research and Knowledge Transfer* (Ottawa: Association of Universities and Colleges of Canada, 2005).

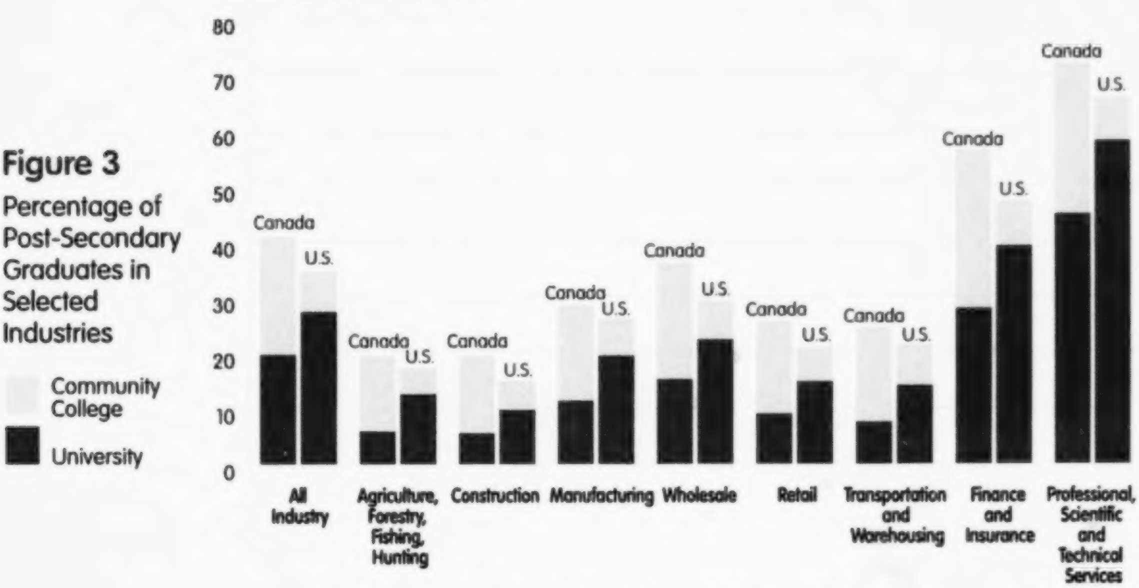
Demand Considerations

Employment of Highly Qualified Personnel

Canadian firms' demand for highly skilled workers is low compared with that of other countries, reflecting a weaker commitment to research and (more generally) innovation. This statement is supported by a broad set of indicators. For example, Canadian firms across most industries employ a higher percentage of community-college-educated workers than their counterparts in the U.S., but employ a lower percentage of university-educated workers (see Figure 3). A similar story emerges for advanced degrees – Canadian companies employ fewer PhDs than U.S. firms across nearly all sectors of the economy.[6]

Figure 3

Percentage of Post-Secondary Graduates in Selected Industries



Sources: Statistics Canada, Census of Population, 2001, and U.S. Census Bureau, United States Census, 2000.

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[6] The one exception is architecture and engineering, in which Canadian firms employ slightly more PhDs per worker than U.S. firms. This comparison is taken from Organisation for Economic Co-operation and Development, *Education at a Glance 2002* (Paris: Organisation for Economic Co-operation and Development, October 2002).

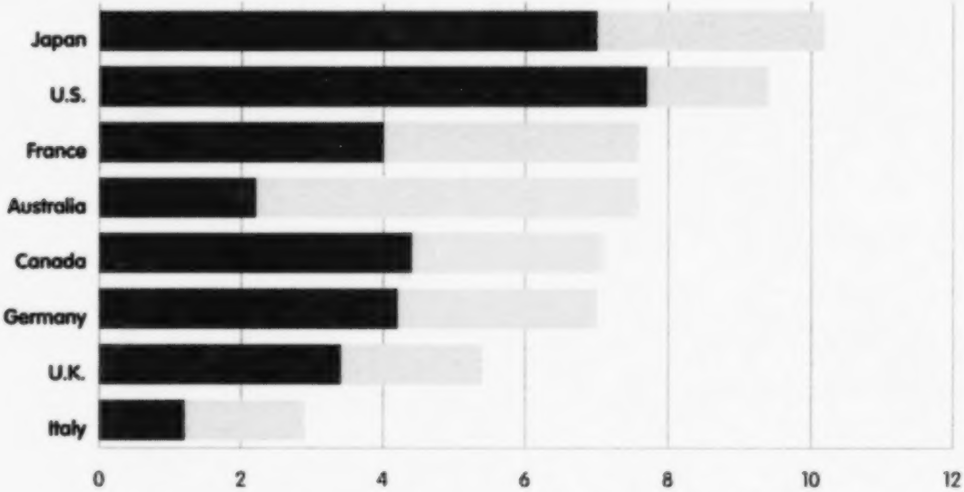
OECD data shows that U.S. and Japanese companies employ significantly more researchers per thousand employees than do Canadian firms (see Figure 4).

Figure 4

Researchers (per thousand employees, 2003 or latest year)

■ Business

□ Other



Source: Organisation for Economic Co-operation and Development. Main Science and Technology Indicators database, March 2006.

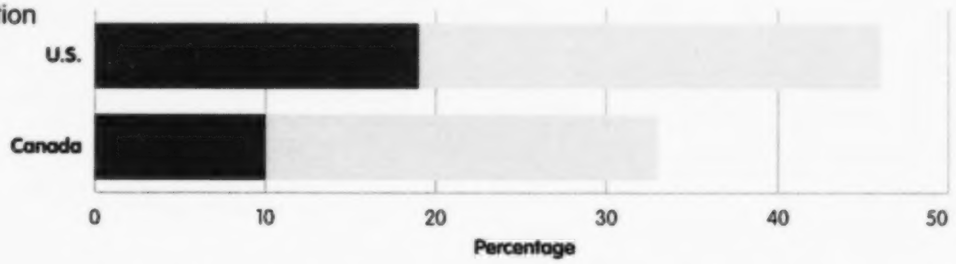
Finally, Canadian managers are much less likely to have a university education than U.S. managers, and are about half as likely to have a business degree (see Figure 5). U.S. financial professionals are twice as likely to have a university degree than their Canadian counterparts (18 percent versus 8 percent).

Figure 5

Managers with a University Education (%)

■ Business

□ Other



Sources: Statistics Canada, Census of Population, 2001, and U.S. Census Bureau, United States Census, 1996.

Returns to Higher Education

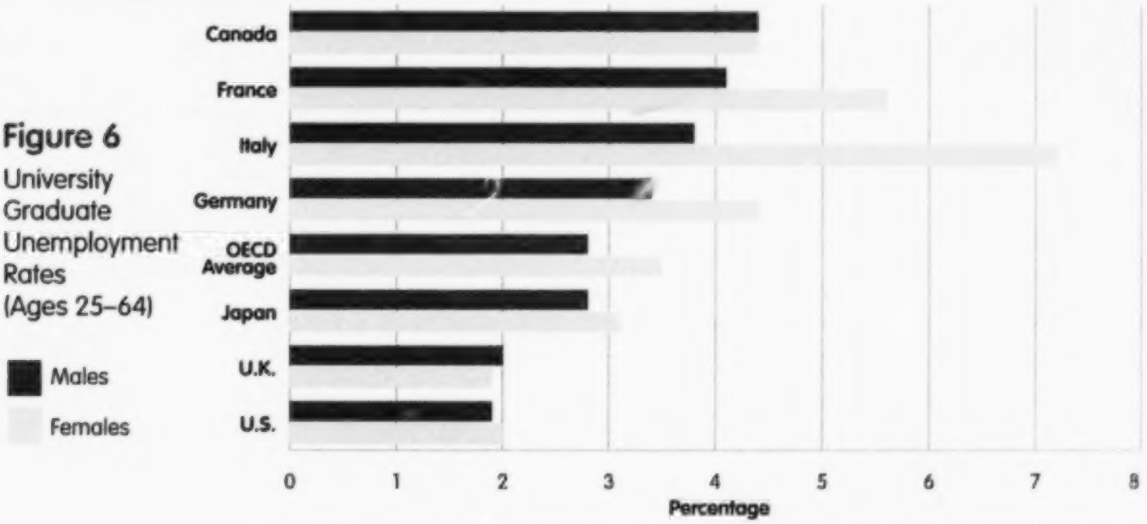
There is little evidence to suggest that supply constraints account for the relatively low use of highly qualified workers in Canada's private sector. When measured by wage rates relative to the average worker, returns on higher education are lower in Canada than in many of its key competitors. OECD data indicates that Canada ranks fifth among the six G7 countries for which data is available in terms of the relative return on university and advanced degrees.[7]

Compared with Americans, Canadians who have a university degree earn a much smaller wage premium relative to their colleagues who have only a high school diploma. Statistics Canada estimates this wage premium to be about 20 percent lower for men and 25 percent lower for women in Canada than in the U.S.[8] Its analysis concluded that the wage patterns for highly educated workers do not support the notion of a widespread imbalance between the demand and supply of highly skilled workers in Canada.

The unemployment rate for university graduates in Canada is among the highest in the G7 (see Figure 6). Indeed, Canada's unemployment rate for males is the highest in the G7. Unemployment rates for Canadian university graduates are about twice the rate of those in the U.S.

Figure 6

University Graduate Unemployment Rates (Ages 25–64)



Source: Organisation for Economic Co-operation and Development, *Education at a Glance 2003*, Table A12.2.

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[7] Organisation for Economic Co-operation and Development, *Education at a Glance 2005* (Paris: Organisation for Economic Co-operation and Development, September 2005). Data for Japan is not available.

[8] René Morissette et al., *Relative Wage Patterns among the Highly Educated in a Knowledge-based Economy* (Ottawa: Statistics Canada, September 2004).

Conclusion

Weaker demand for researchers and highly skilled workers in Canada is consistent with evidence from the World Economic Forum's *Executive Opinion Survey*, which indicates that business strategies in Canada do not focus on innovation or support the intensive use of highly qualified personnel. This points to a need to increase the demand for – and encourage the placement of – highly qualified personnel in Canadian firms, helping to increase their capacity to develop and bring innovative products and services to market. From the supply side of the equation, it is evident that greater uptake within the private sector in engaging in research and employing more highly qualified personnel will require faster growth in the supply of skilled graduates.

We were asked to advise on how to bring about these necessary changes. First, it is clear that addressing deficiencies in Canada's general business framework policies will increase the returns to highly qualified personnel and, thus, boost demand. Key issues to consider in this regard are outlined in Section IV of Volume I of our report.

In our judgment, and consistent with what we heard during the executive round tables and from stakeholder submissions, another important key to understanding the weak business demand for highly qualified personnel in Canada is the perception that introducing these relatively high-cost resources into a firm involves a high risk of yielding low returns, especially in the first few years. Accordingly, we are of the view that reducing this short-term risk is critical to increasing the hiring of commercialization-enhancing highly qualified personnel by Canadian business. We have identified the following strategies to achieve this:

- Reduce the risk, by allowing firms to "test the waters" and discover the value that highly qualified workers can bring, without the firms making as large an up-front financial commitment as would otherwise be the case.
- Reduce the cost by partially funding those years of employment when recent graduates are developing a general commercial awareness and making the transition from an academic environment to the business sector.
- Improve the business readiness of highly skilled workers so that they can contribute to a firm's bottom line as quickly as possible.
- Expand the range of skills and experience of highly qualified personnel who are in the labour market.

These strategies are embodied in our recommendations on talent.

Research:

A Key Determinant of Productivity, Growth, Innovation and Commercialization

> Innovation and technology diffusion are important to economic growth.... But their role has changed in recent years. Increased competition and globalisation has spurred a greater market orientation of funding, resulting in strong growth of business R&D, and scientific research now has a direct impact on innovation in key areas such as biotechnology and [information and communications technologies].... But despite globalisation, growing competition and the diffusion of [information and communications technologies], the degree of innovation differs considerably across countries.
>
> In addition, while expenditure on innovation has risen in several OECD countries over the past decade, only few have experienced higher growth in MFP [multi-factor productivity]....[9] OECD work shows that R&D is an important driver of MFP.... Foreign R&D is particularly important for most OECD countries (the United States being an exception), since the bulk of innovation and technological change in small countries is based on R&D that is performed abroad. But domestic R&D, i.e. business, government and university research, is also an important driver of MFP growth. It is also key in tapping into foreign knowledge; countries that invest in their own R&D benefit most from foreign R&D. The important role of R&D in MFP growth and the rise in R&D spending suggests that there may be unexploited potential for improved growth performance in many OECD countries.
>
> – Organisation for Economic Co-operation and Development,
> *The New Economy: Beyond the Hype — The OECD Growth Project*
> (Paris: Organisation for Economic Co-operation and Development, 2001), p. 41.

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[9] MFP provides a measure of the overall efficiency of production and can be estimated by dividing the value of output by the sum of the value of all inputs used in production (in particular, labour and capital).

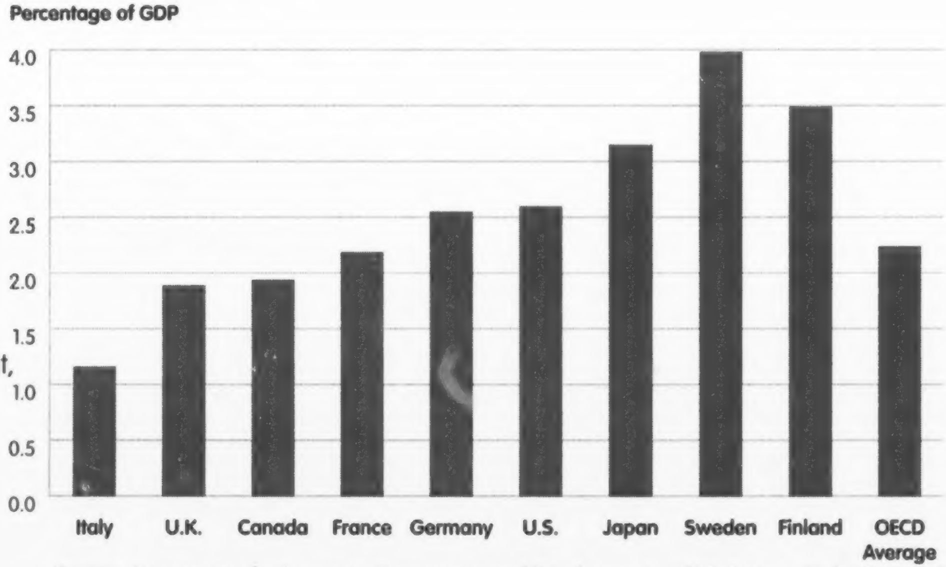
Total Expenditures on Research and Development

Studies by the OECD confirm that R&D spending has a strong impact on productivity growth, which, in turn, contributes to higher living standards.[10]

Canada invests significantly less in R&D than the U.S. and many other OECD countries. Overall, Canada ranks fifth in the G7 on gross domestic expenditure on R&D (GERD) relative to GDP (see Figure 7). At 1.9 percent in 2003, Canada's GERD-to-GDP ratio is also below the OECD average of 2.2 percent, and falls well behind those of smaller countries such as Sweden (4.0 percent) and Finland (3.5 percent).

Figure 7

Gross Domestic Expenditure on Research and Development, 2003



Source: Organisation for Economic Co-operation and Development, *OECD Science, Technology and Industry Scoreboard 2005.*

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[10] Dominique Guellec and Bruno van Pottelsberghe de la Potterie, *R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries*, Directorate for Science, Technology and Industry Working Paper 2001/3 (Paris: Organisation for Economic Co-operation and Development, June 2001).

Research and Development in the Higher Education Sector

The Government of Canada has significantly increased investment in research since 1997, largely by increasing funding for the federal research granting agencies and by establishing several key programs, such as the Canada Foundation for Innovation and the Canada Research Chairs. While G7 countries increased their R&D spending by an average of 30 percent over the past decade, Canada saw its spending increase by 70 percent.

Most of this increase in R&D has been directed to the higher education sector. In fact, at 0.7 percent of GDP, Canada leads all G7 countries in terms of this indicator. The OECD average is 0.4 percent of GDP, which is similar to that recorded in most G7 countries other than Canada.[11]

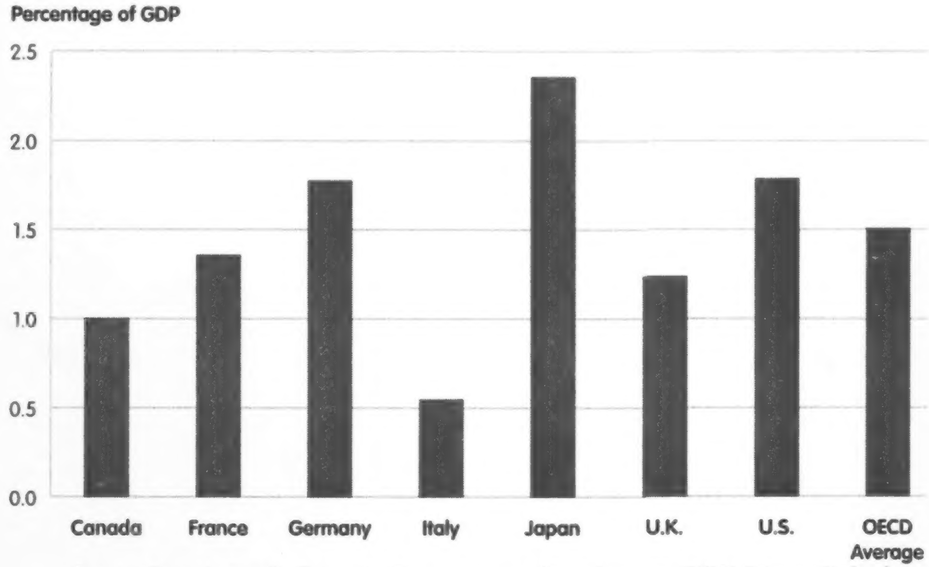
Although generating economic benefits is not the primary objective for most publicly funded R&D, such R&D can have large, indirect impacts on growth. The OECD notes that U.S. funding for the National Institutes of Health has been an important driver of that country's booming biotechnology sector, and that defence R&D funding has contributed to many important innovations in information and communications technologies.[12]

Research and Development in the Business Sector

On average, Canadian businesses spend much less on R&D than do their competitors in other major countries. In Canada, business enterprise expenditure on R&D (BERD) represented 1.0 percent of GDP in 2003, significantly below the 1.8 percent recorded in the U.S. and the OECD average of 1.5 percent (see Figure 8). This low R&D intensity implies that Canada's private sector accounts for only 55 percent of all R&D spending in Canada, compared with the average of 68 percent for OECD countries.

Figure 8

Business Expenditure on Research and Development, 2003



Source: Organisation for Economic Co-operation and Development, *OECD Science, Technology and Industry Scoreboard 2005*.

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11. Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators: 2005/2 edition* (Paris: Organisation for Economic Co-operation and Development, 2005).
12. Organisation for Economic Co-operation and Development, *The New Economy: Beyond the Hype — The OECD Growth Project* (Paris: Organisation for Economic Co-operation and Development, 2001), pp. 41-48.

There are no completely satisfactory explanations for Canada's weak performance in business R&D. Three quarters of the gap in Canada's R&D intensity relative to the U.S. is attributable to lower R&D intensities across industries. Much of this difference is due to lower R&D spending in the wholesale trade, retail trade and motor vehicle industries. Although research intensities in such high-technology sectors as computer and telecommunications equipment and pharmaceuticals compare favourably with those in the U.S., these industries account for a smaller share of the Canadian economy (see Table 1).

Table 1

Research Intensity in Canada and the United States

	Research Intensity			GDP Share	
	Canada	U.S.	Ratio (Canada:U.S.)	Canada	U.S.
Office and computer equipment	53.63%	25.80%	2.08	0.06%	0.22%
Radio, TV and communications equipment	27.87%	20.54%	1.36	0.55%	0.82%
Pharmaceuticals	27.51%	20.92%	1.32	0.33%	0.68%
Other transportation equipment	14.48%	24.25%	0.60	0.70%	0.68%
Electrical machinery	3.63%	10.86%	0.33	0.37%	0.29%
Mechanical and electrical not elsewhere classified	2.09%	5.50%	0.38	1.31%	1.02%
Refined petroleum, plastics and chemicals	1.63%	5.33%	0.31	2.27%	1.83%
Basic metals	1.28%	0.93%	1.38	0.95%	0.41%
Textiles	1.06%	0.64%	1.66	0.27%	0.26%
Fabricated metal products	1.03%	1.59%	0.65	1.31%	1.11%
Furniture	0.76%	1.58%	0.48	NA	0.86%
Motor vehicles	0.75%	15.30%	0.05	2.10%	1.02%
Food and beverages	0.55%	0.98%	0.56	2.11%	1.41%
Wood and paper	0.39%	1.44%	0.27	4.02%	2.43%
Other mining products	0.29%	1.49%	0.19	0.48%	0.44%
Total manufacturing	**3.65%**	**8.27%**	**0.44**	**18.32%**	**14.42%**

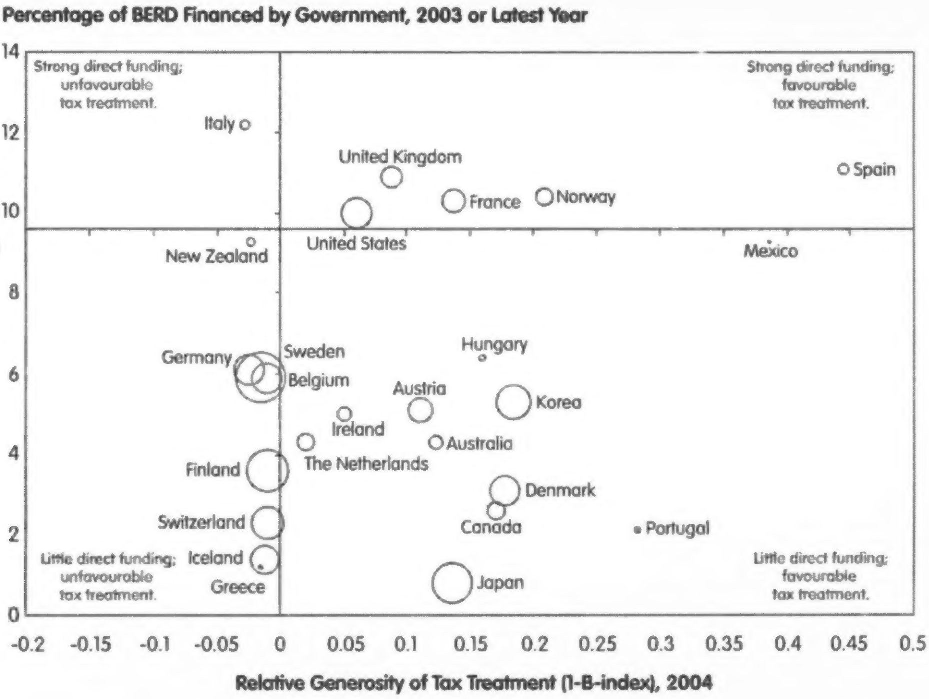
	Research Intensity			GDP Share	
	Canada	U.S.	Ratio (Canada:U.S.)	Canada	U.S.
Community, social and personal services	0.00%	0.00%	-	19.59%	23.04%
Hotels and restaurants	0.00%	0.00%	-	2.39%	2.62%
Transport and storage	0.05%	0.15%	0.33	4.21%	2.93%
Financial intermediation	0.30%	0.21%	1.43	7.33%	7.73%
Post and telecommunications	0.35%	0.49%	0.71	2.76%	3.39%
Wholesale and retail	0.69%	1.25%	0.55	11.20%	12.82%
Real estate, renting and business activities	1.11%	1.12%	0.99	18.08%	24.28%
Total services	**0.48%**	**0.82%**	**0.59**	**65.57%**	**76.81%**

Source: Adapted from Aled ab Iorwerth, "Canada's Low Business R&D Intensity: The Role of Industry Composition." Working Paper 2005-03. Ottawa: Department of Finance Canada, 2005. Underlying data is from the Organisation for Economic Co-operation and Development (OECD) R&D Expenditure by Industry Database and the OECD STAN Database for Industrial Analysis.

The significant degree of foreign ownership and the higher proportion of small firms in the Canadian economy have both been identified as factors that could explain part of the Canada-U.S. R&D gap. On balance, economists have found little evidence to support such assertions. The impact of government policies on R&D activity is also unclear. Government directly funds 2.6 percent of Canadian BERD – a much smaller percentage than in the U.S. (10 percent) and the OECD as a whole (7.2 percent) (see Figure 9). However, in terms of indirect support, Canadian R&D tax credits are widely regarded as among the most generous in the world.

Figure 9

Direct and Indirect Funding of Business Research and Development



Notes: The size of the bubble indicates the ratio BERD/GDP. B-Index: before-tax income needed to break even on $1 of R&D outlay; BERD: business expenditures on research and development; GDP: gross domestic product.

Source: Adapted from Organisation for Economic Co-operation and Development, *Tax Incentives for Research and Development: Trends and Issues* (Paris, Organisation for Economic Co-operation and Development, 2004), p. 11.

Most OECD governments encourage R&D and innovation in the private sector, with support typically taking the form of grants, subsidies, loans or tax credits. There are, however, key differences in the types and scale of such support. Direct support, such as grants, is more selective and can potentially be channelled to areas that have high potential returns in a way that tax credits cannot. Empirical research suggests that direct support can lead to additional private funding. The evidence also shows that the level of funding is important – low levels boost overall business funding only marginally, whereas high levels crowd out private R&D. Direct support is also shown to be more effective in leveraging additional private sector R&D if government policies in this area are stable over time. Supporting business R&D can be expensive, and governments should continually monitor the costs of such support against the potential benefits.[13]

Public–private partnerships can be effective in sharing the risks and costs of risky R&D projects. However, competitive procedures are important when deciding on projects, and the use of consortia may help governments avoid supporting only one firm as the winner.[14]

Other Indicators

Patents are considered to be an important indicator of the output of research activity. In terms of patenting activity, no matter what the measure, Canada is well below the approximate 10:1 ratio to the U.S. that would be expected given the relative size of the two economies and populations. This result holds whether one examines patents awarded on a per-capita, per-worker or per-unit of R&D basis. For example, a 2004 study by the OECD showed that there are 17 triadic patent families per million population in Canada, compared with 70 in Germany and 53 in the U.S.[15]

According to the World Economic Forum, Canadian businesses rank 27th in the world in terms of their propensity to compete based on unique products and processes (see Figure 10). In the most recent *Global Competitiveness Report*, the World Economic Forum suggests that the underlying cause of Canada's lacklustre research performance may be that Canadian firms do not seek competitive advantage through innovation, but, rather, through other strategies, such as cost minimization.

The reasons for this are unclear. Roger L. Martin, Dean of the Joseph L. Rotman School of Management, has suggested that Canadian businesses do not face high levels of pressure from capable rivals and sophisticated customers, and are not benefiting from local, specialized support. Factors that affect the competitive intensity within Canada could include the small size of the domestic market, foreign direct investment restrictions in key sectors, internal trade barriers and burdensome regulations. Other possible reasons for Canada's poor record in this area include a reliance on our resource wealth to generate a high standard of living, and the impacts of higher corporate tax rates and other parts of Canada's general business frameworks on firms' incentive to innovate.[16]

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[13] Dominique Guellec and Bruno van Pottelsberghe, *The Impact of Public R&D Expenditure on Business R&D*, Directorate for Science, Technology and Industry Working Paper 2000/4 (Paris: Organisation for Economic Co-operation and Development, June 2000).

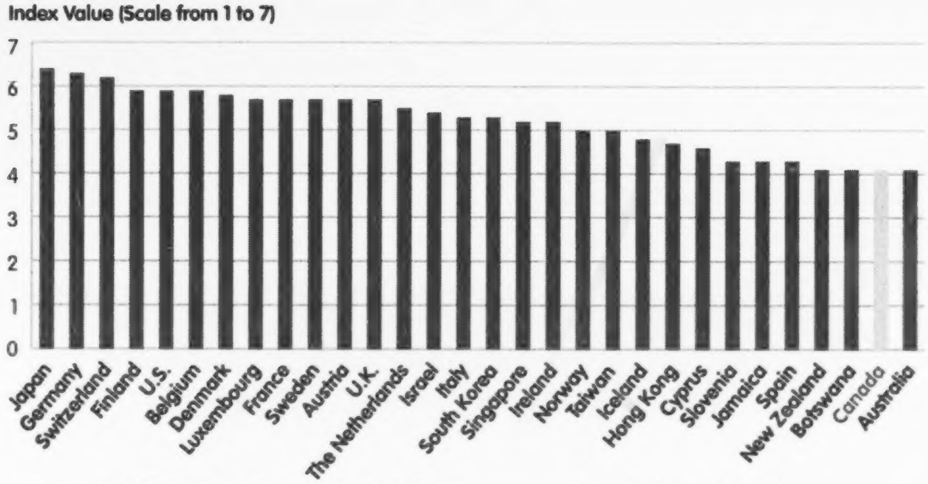
[14] Organisation for Economic Co-operation and Development, *The New Economy: Beyond the Hype — The OECD Growth Project* (Paris: Organisation for Economic Co-operation and Development, 2001), pp. 41–48.

[15] Organisation for Economic Co-operation and Development, *Compendium of Patent Statistics 2004* (Paris: Organisation for Economic Co-operation and Development, 2004). Triadic patent families are defined as a set of patents held at the European, U.S. and Japanese patent offices to protect the same invention. According to the OECD, this indicator provides an improved picture of the innovative activity at an international level.

[16] For a thorough examination of many of the factors cited in this paragraph, see Roger L. Martin, *Realizing Canada's Prosperity Potential* (Toronto: Institute for Competitiveness and Prosperity, January 2005).

Figure 10

Competitive Advantage Based on Unique Products and Processes, World Economic Forum, 2005–06



Source: World Economic Forum, *The Global Competitiveness Report 2005–2006*, 2005.

Conclusion

The preceding analysis clearly points to the need for the private sector to pursue R&D activities more aggressively. Although not every dollar spent by firms on research will lead to new marketable products and processes, commercialization outcomes will improve significantly with a greater emphasis on research.

The panel believes that measures designed to encourage businesses to take that crucial first step of becoming R&D performers in the first place will improve Canada's commercialization performance. For firms that already perform R&D, incentives to expand their research base will expand the scope and scale of projects, and improve the likelihood of successful commercialization.

Canadian companies under-invest in R&D for a variety of reasons. They may simply believe that the economic return to this activity is lower in Canada than elsewhere. Alternatively, companies may systematically underestimate the potential returns on risky research ventures, or find that they cannot sustain funding over the entire life of a project. The latter applies in particular to SMEs.

As was argued in the section on talent, we expect that improving Canada's general business frameworks will boost the incentives (and thus the demand) for firms to invest in R&D. However, based on examples from other countries, we believe that there is a clear role for government in sharing the costs of risky R&D activities with the private sector.[17] We have identified three key strategies to achieve this:

- Canada should look to the example of programs in the European Union, the U.S. and elsewhere, where governments partner with the private sector to share the risks of undertaking long-term research programs in areas that have strong commercial potential. The evidence suggests that additional support for industrial research levers additional private investment from firms.
- Since firms face significant difficulty in acquiring capital from private sources before they are able to demonstrate the commercial value of their ideas, Canada should increase its support for existing government programs that underwrite proof-of-concept or proof-of-principle activities. This will help companies bridge this critical financing gap.
- Given the unique challenges that smaller companies face, Canada should emulate the demonstrated success of the U.S. Small Business Innovation Research program in boosting SME research activity and commercial success. Indeed, this success has already convinced many other countries (the U.K., for example) to introduce similar programs.

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[17] As noted previously, although Canadian firms benefit from a generous tax credit for business R&D expenditures, Canadian governments provide less direct financing for private sector research activities than do governments in many other countries.

Capital:

A Key Determinant of Productivity, Growth, Innovation and Successful Commercialization

> [O]ne important impediment to entry for new innovative firms is the lack of financing. Start-ups obviously have no track record and, especially in the [information and communications technologies] sector, often very little collateral, which makes it difficult for them to obtain bank loans or other forms of debt financing. Personal savings and other informal sources (e.g. borrowing from friends and family) may help to raise some initial funds. But for the recent wave of innovative start-ups, the main source of funding has tended to be equity finance, whether venture capital or from so-called business angels. These private investors do more than just supply funds, they help start-ups to develop as businesses, providing advice and even management. They become crisis managers when times turn bad and contribute to firms' survival.
>
> Innovative start-ups may not flourish in countries without a broad venture capital culture. And not all OECD countries have developed venture capital activity to the same extent. The United States invests more in this way as a percentage of GDP or per company than any other country, and informal private investment is believed to be greater than that again....
>
> Business angels are generally wealthy individuals with substantial business experience who invest directly in start-ups. They tend to focus more on early-stage financing than institutional investors and they provide more managerial and business advice through their greater personal involvement. Although data are scarce (partly because these individuals are hard to identify and are often reluctant to reveal exact information), total funding by business angels is estimated to be several times greater than all other forms of private equity finance.
>
> – Organisation for Economic Co-operation and Development,
> *The New Economy: Beyond the Hype – The OECD Growth Project*
> (Paris: Organisation for Economic Co-operation and Development, 2001), pp. 74–76.

Overview

Firms that need and seek risk capital financing are often high-growth, knowledge-based firms that have an idea, concept or product that requires an incubation period before generating revenues and profits. Although such firms play a strong role in promoting growth, productivity and innovation, they often face unique challenges in securing capital, as they lack sufficient tangible assets to secure bank loans or other types of formal financing. Risk capital – financing instruments that match the long-term, high-risk nature of these businesses – is therefore key to funding these innovative, high-growth firms.

Companies at a very early stage of development are often almost entirely dependent on risk capital from owners' personal resources and informal investors (e.g. family, friends, private individuals or angel investors). New start-ups require financing for later-stage product development and marketing, and require venture capital in progressively larger amounts to fund market entry and expansion. When markets have been established, firms in later stages often require growing amounts of equity investment – amounts normally available only from public capital markets through initial public offerings, or from leveraged buyouts or other forms of private equity.

Marketplace Gaps

The existence of marketplace gaps, or systemic weakness that prevents an optimal supply of capital to start-up and early-stage firms, is difficult to determine. Many early-stage firms claim that there is a shortage of patient capital to finance development of their ideas, a problem thought to be particularly evident in regions outside of Canada's major metropolitan areas. Providers of capital, on the other hand, respond that there is a shortage of investor-ready firms (e.g. that too many firms have weak management teams or poor business strategies, or lack general business know-how).

The consensus among industry experts is that there are financing challenges in two main areas: 1) the seed and start-up phases of firms' operations; and 2) the late or expansion phases. These challenges are not unique to Canada. They exist in all countries, including the U.S., which has the deepest and most developed capital markets in the world. Because of data limitations, weaknesses in the risk capital market for early-stage, informal investment must be assessed largely on the basis of anecdotal evidence only. With respect to later-stage financing gaps, comprehensive data on venture capital exists.

Seed and Start-Up Phases

As this type of investment is informal in nature, quality data is limited. A recent study prepared for Industry Canada uses data from Statistics Canada's *Survey on Financing of Small and Medium Enterprises* to estimate the flow and stock of capital available for informal investment. The annual flow of informal investment was estimated to total $11.4 billion in 2001, with $3.5 billion of this coming from angel investors.[18]

As different methodologies were used to compile data in Canada and the U.S., these Canadian estimates on informal investment cannot be compared directly with U.S. data. However, the *Global Entrepreneurship Monitor* ranks Canada ninth out of 18 countries in terms of the overall level of informal investment.[19] Moreover, anecdotal evidence suggests that the U.S. angel market is more mature than Canada's, and that U.S. angel investors have greater wealth to reinvest, due to past successes. The *Global Entrepreneurship Monitor* study suggests that the U.S. has 53 percent more informal investors per capita than Canada. Although the number of angel networks in Canada is not known, it is likely to be well below 20, whereas there are an estimated 200 angel networks in the U.S.

Comprehensive data on early-stage venture capital investment is available, however, and shows that Canadian venture capital funds tend to invest more often in early-stage firms than do their U.S. counterparts (see Figure 11). This investment has been necessary in order to ensure that there is adequate deal flow for later-stage opportunities (and is, perhaps, a reflection of weak angel investment activity), but has tended to lower overall return on venture capital. Given these low returns, there is concern among industry observers that venture capital funds will vacate their early-stage investments. In this event, angel investors would find it difficult to provide adequate financing to firms that require early-stage capital.

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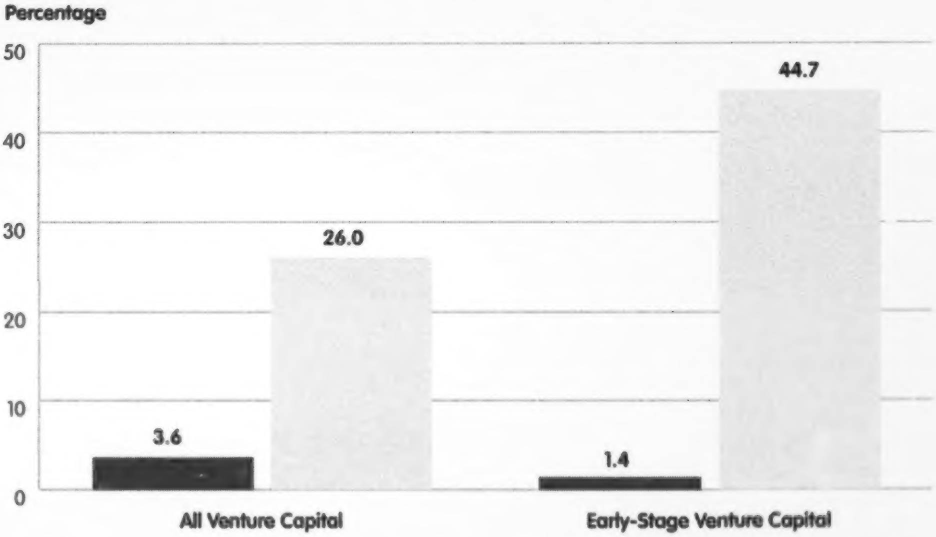
18. Equinox Management Consultants Ltd. compiled *Estimating Informal Investment in Canada* (Ottawa: Equinox Management Consultants Ltd., 2005) for Industry Canada's Small Business Policy Branch. Angel investors invest at arm's length but provide a wide range of technical and managerial advice to the firm. Informal investments also include those from friends and family, and from arm's-length investors who assume an active management role. See the November 2005 *Small Business Quarterly* (Vol. 7, No. 3) for more details (www.strategis.gc.ca/SMEquarterly).

19. Nathaly Riverin et al., *Global Entrepreneurship Monitor: Canadian National Report 2003* (Montréal: Global Entrepreneurship Monitor Canada, 2005). Led by HEC Montréal and the Sauder School of Business, University of British Columbia.

Figure 11

Before-Tax Annual Rate of Return on Venture Capital Investment, 1994–2004



Sources: Venture Economics / National Venture Capital Association (U.S.) and Thomson Macdonald (Canada). Note that U.S. returns are net; Canadian returns are gross.

Late or Expansion Phases

On a per-capita basis, Canada compares well with the U.S. in terms of venture capital invested and new capital raised. Notwithstanding this, there are some key structural differences between the Canadian and U.S. venture capital markets (see Table 2):[20]

- **The average deal size is nearly four times greater in the U.S. than in Canada. As noted previously, returns on venture capital investments are much lower in Canada. Although based on a small sample size, the overall 10-year rate of return (ending December 2004) for Canadian venture capital was 3.6 percent, compared with 26.0 percent in the U.S.**
- **Private, independent funds dominate the U.S. market, accounting for an average of 80 percent of the capital under management. The comparable figure for Canada is only 25 percent. The Canadian market is dominated by labour-sponsored venture capital corporations. Some analysts have questioned the effectiveness of these corporations in providing quality risk capital to technology-based firms.[21]**
- **Institutional investors allocate a much smaller share of their capital to private equity than do their U.S. counterparts. Large pension funds account for only 18 percent of the venture capital raised in Canada since 1996 but account for 46 percent of all venture capital raised in the U.S. over the same period.[22]**

In addition to these differences, venture capital funds in Canada are younger (at an average age of 5 years, compared with 11 in the U.S.), smaller (U.S. venture capital professionals manage roughly two and a half times more money than Canadian venture capital managers) and less specialized.[23] These factors translate into less-experienced venture capital professionals, limiting their ability to assess opportunities and provide value-added support to firms.

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[20] All Canadian venture capital data is from Thomson Macdonald (2005) unless otherwise indicated. U.S. data is from Venture Economics / National Venture Capital Association (2005).

[21] See, for example, Douglas J. Cumming and Jeffrey G. MacIntosh, *Canadian Labour-Sponsored Venture Capital Corporations: Bane or Boon?* (Toronto: Capital Markets Institute, University of Toronto, April 2003).

[22] Macdonald & Associates Limited, *Finding the Key: Canadian Institutional Investors and Private Equity* (Ottawa: Industry Canada, June 2004).

[23] Information on age of firms is from Goodman and Carr LLP, and McKinsey & Company, *Private Equity Canada* (Toronto: Goodman and Carr LLP, and McKinsey & Company, 2003). Information on specialization is from E. Wayne Clendenning & Associates, *Assessment and Comparison of Key Issues Regarding the Operation of Venture Capital Markets in Canada and the U.S. and their Implications for Private Sector Participants and Government Policy* (Ottawa: E. Wayne Clendenning & Associates, July 2002).

The smaller size of Canadian venture capital funds implies that the larger investments required by firms in their expansion phase are at risk. Moreover, large, late-stage venture capital financings of $20 million or more through syndications among Canadian venture capitalists are virtually non-existent.

However, foreign venture capital financing has grown dramatically in recent years, rising from 3 percent of all venture capital financing in 1998 in Canada to 27 percent in 2005. The large majority of foreign investors that are investing in Canada do so in syndication with Canadian venture capital firms. A study conducted by PricewaterhouseCoopers concluded that the Canadian tax regime was viewed to be a significant deterrent to investing in Canada.[24] Improving the tax treatment of U.S. venture capital entering into Canada will, therefore, promote greater syndication.

Although Canada does need to address barriers to foreign sources of venture capital, it is also important to establish conditions for the continued growth and maturity of the venture capital industry in Canada. This industry can provide added value to firms' development within Canada in a way that U.S. firms could only provide by moving them south of the border.

The OECD notes that governments in Europe (and Canada) have participated in venture capital funds to increase the supply of capital available for investment. It argues that public intervention may be warranted to address clear market failures, and suggests that seed financing by government may leverage additional private sector risk capital. There is concern, however, that governments are not best placed to identify those firms in which investment should take place, and that these efforts may be ineffective if other important conditions, such as management advice and proper regulations toward businesses, are missing.[25]

Table 2

Comparison of Canadian and United States Venture Capital Markets, 2004

	CANADA	U.S.	APPROXIMATE DIFFERENCE
Venture capital (VC) - $ Invested	$1.8B	$27.3B	15x
Early-stage $ invested	$0.9B	$5.5B	6x
Late-stage $ invested	$0.9B	$21.8B	24x
VC - Average deal size	$3.0M	$11.4M	4x
VC - Average early-stage deal size	$2.8M	$6.1M	2.2x
VC - Average late-stage deal size	$3.2M	$13.4M	4x
VC - Capital under management	$21B	$339B	16x
VC - Number of VC funds	174	1 949	11x
VC - Average firm size	$118M	$304M	2.6x
VC - Average size of VC funds	$87M	$119M	1.4x
VC - Number of VC professionals	1 135	10 471	9x
VC - $/professionals	$13.3M	$32.5M	2.4x
Population	31.91M	296.79M	9x
Gross domestic product (GDP)	$1 288B	$15 256B	12x

Source: Thomson Macdonald, 2005 (Canada) and Venture Economics / National Venture Capital Association, 2005 (U.S.). Population and GDP information is from Global Insight and CANSIM.

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24. PricewaterhouseCoopers LLP, *Foreign VC Investment In Canada: A Profile of Foreign Investors and Domestic Investees* (Toronto: PricewaterhouseCoopers LLP, October 2003).

25. Organisation for Economic Co-operation and Development, *The New Economy: Beyond the Hype — The OECD Growth Project* (Paris: Organisation for Economic Co-operation and Development, 2001), drawing on results from *Benchmarking Enterprise Policy: First results from the Scoreboard*, by the Commission of the European Communities (Brussels: European Commission, October 2000).

Conclusion

There is considerable disagreement – among experts and stakeholders – about whether Canada faces a shortage of patient risk capital or a shortage of firms that can offer compelling opportunities to potential investors. We believe that both supply and demand considerations must be addressed. We also agree with the general consensus – based on quantitative and anecdotal evidence – that Canadian firms face financing challenges at the start-up and early stages, as well as the late or expansion phase.

In our judgment, start-ups and other early-stage firms will benefit from an increased pool of angel investment. Although different options for this were considered – including a tax credit for angel investors – we concluded that co-funding arrangements hold the most promise for increasing the amount of capital available for investment in early-stage firms.

We believe that efforts are also needed to increase the quality of demand from early-stage companies for investment capital. Quite apart from the capital provided by angel investors, early-stage firms benefit substantially from the business acumen and experience of angel investors. Access to this knowledge helps make firms more "investor-ready" and positions them for faster growth, as demonstrated by the results of a previous federal pilot program, the Canada Community Investment Plan.[26]

Action to address the early-stage funding challenges outlined will help address marketplace weaknesses at the late or expansion phase. Venture capital data clearly shows that the Canadian venture capital market is very different from that of the U.S., mainly due to differences in the scale and composition of capital providers. As noted previously, two key distinguishing features of the Canadian venture capital market are the dominant position of labour-sponsored venture capital corporations and the weak participation of institutional investors. We believe an in-depth review of Canada's expansion-stage venture capital market is warranted to examine these important issues.

Improved access to foreign sources of risk capital will not only provide Canadian firms with better access to larger pools of capital, but will allow them to benefit from the more experienced and specialized financial expertise available south of the border. We, therefore, agree with the Canadian Task Force on Early Stage Funding, which identified a number of cost-effective tax measures that would stimulate a greater flow of foreign risk capital to finance the expansion phase activities of high-growth, knowledge-based Canadian firms.

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[26] Consult strategis.ic.gc.ca/epic/internet/incip-picc.nsf/en/h_cw01102e.html for the full results from the Canada Community Investment Plan.

Appendix H

Additional Issues for Longer-Term Consideration

The panel was unable to assess all the research and position papers that have been prepared on issues that relate to commercialization in Canada, or to assess all papers in ways that led to agreement on specific and actionable recommendations. However, we agreed there is a need to tackle key business framework policies to increase the incentive for Canadian businesses to commercialize.

Section IV in Volume I of this report sets out our views on the need to analyze key business frameworks in greater detail, including improvements to the regulatory system, modernization of intellectual property laws, improvements to the tax regime, and increases in the competitive intensity within the Canadian marketplace. In our discussions, we also identified other issues that merit attention. Following is a list, with brief outlines of issues that were raised. Some items are more extensive in their reach than others, but we believe that the Commercialization Partnership Board (CPB) should develop a work plan to assess recommendations and action items in these areas. While panel members agreed on the importance of these issues, we also recognized that stakeholders have identified other areas that should also be addressed in the longer term.

Thinking Globally

We strongly believe that Canadians need to think globally in their research activities and business operations. Initiatives such as the Canada-Israel Industrial Research & Development Foundation are instructive. The Foundation promotes and markets the benefits of joint research and development (R&D) collaboration between Canadian and Israeli firms, matches companies in one country with research partners in the other, and contributes to binational industrial R&D initiatives. New international science and technology (S&T) cooperation agreements with emerging markets build on this model, expanding government support for joint R&D collaborations among Canadian innovators and their partners in China, India and Brazil. The CPB should undertake a review of the effectiveness of these activities – and other potential measures – with a view to enhancing efforts to stimulate more international research collaboration and promote the acquisition and dissemination of global S&T by Canadian firms.

The CPB could also examine how to better integrate support for global market development into domestic programming. For example, funding under the proposed Commercialization Superfund and Canadian SME Partnerships Initiative may be accompanied by efforts to accelerate the global marketing of new, commercial-ready technology. Funding for greater development of international partnering, global marketing support, and building and/or accessing international distribution networks should also be considered.

Strengthening the Impact of Technology Clusters

Clusters play an important role in commercialization. Firms that are part of clusters gain from knowledge spillover and shared access to the local knowledge base and other resources. Companies benefit from close connection to key suppliers and customers, and from easier access to specialized inputs, including components, machinery and business services. Perhaps most importantly, clusters can act as a magnet for skilled workers, which combine with the location of specialized training and educational institutions to provide a steady supply of highly qualified labour to firms.[1]

We do not believe that governments can artificially create clusters. Moreover, clusters do not exist simply because a chamber of commerce says they do. Rather, their existence is confirmed when they receive broad, external recognition; when capital and talent find their way to them; and when research activity takes place within them. Governments can, however, nurture the further development of existing clusters. For example, at early stages, strategic investments in public research and fourth-pillar institutions can strengthen clusters by developing specialized R&D capabilities and helping create pools of highly qualified workers.[2] At clusters' more mature stages, governments can help by improving the ability of public institutions to network and exchange information with the private sector.[3] We believe that the CPB, given its private sector focus, is the appropriate body to recommend how governments can best support and strengthen successful clusters.

Review of Existing Federal Programs That Support Commercialization

Although it was well beyond what we had the time or capacity to do, we believe it would be timely for the CPB to oversee a review of the 100 or more federal programs that support Canadian commercialization activities either directly or indirectly. This review should enable the creation of a more coherent, coordinated approach to federal support for commercialization, and would dovetail nicely with the federal government's other efforts to improve its program and service delivery through integration and client-centred restructuring. For example, Canada Business serves as a single point of access for federal and provincial/territorial government services, programs and regulatory requirements. The network is operated through collaborative arrangements with provincial and territorial governments, and, in some cases, not-for-profit organizations.

In undertaking this fundamental review, the Government of Canada can look to the example of the U.K. The U.K. Department of Trade and Industry recently completed a review of its business support products, with a view to reducing duplication, ensuring value, and being fiscally responsible and efficient. In 2002, more than 100 programs were replaced with a suite of nine business-support products grouped under four broad themes: succeeding through innovation, achieving best practices in business, raising financing, and regional investment.

The change was accompanied by a transformation of service delivery to small and medium-sized businesses through Business Link, a network of locally based one-stop shops for business support, advice and information.

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1. Meric S. Gertler and David A. Wolfe, *Spaces of Knowledge Flows: Clusters in a Global Context* (Toronto: Program on Globalization and Regional Innovation Systems, Centre for International Studies, University of Toronto, March 2005).
2. Fourth-pillar organizations are usually independent, non-profit entities funded jointly by government and the private sector to provide a catalytic role for the other three pillars: business, government and post-secondary education institutions. For example, Precarn Incorporated was created, and is funded, by partners from these three pillars to support the development of intelligent systems technologies.
3. David A. Wolfe and Matthew Lucas, *Global Networks and Local Linkages: The Paradox of Cluster Development in an Open Economy* (Montréal and Kingston: McGill-Queen's University Press, 2005).

Improving University–Industry Technology Transfer Interactions

A number of initiatives aim to improve the linkages between public research facilities and industry. For example, the Intellectual Property Mobilization Program, managed jointly by the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada and the Canadian Institutes of Health Research, seeks to benefit Canada by accelerating the transfer of knowledge and technology within universities, hospitals and colleges. Canadian universities have committed to tripling their 1999 levels of income from the commercialization of intellectual property by 2010 and have made significant progress to date. Finally, the 2004 federal budget allocated $50 million over five years to develop pilot programs to improve the commercialization of intellectual property from universities and research hospitals. The CPB may find it useful to address this and identify how best to maximize commercial outcomes from public research.

Venture Philanthropy

Panel members discussed the possibility of creating a Canadian venture philanthropy fund to match significant private donations to research and other key supports for knowledge development with public funds. We recognize that appropriate criteria would have to exist in order to safeguard the public good and to reflect sound public policy goals for such a matching program. This may be an idea that the CPB will want to pursue further.

Government Procurement and Commercialization

Many commentators, including The Conference Board of Canada's Leaders' Roundtable on Commercialization, support the use of strategic procurement to boost demand for Canadian products and provide firms with an important first user or anchor client.[4] The Prime Minister's Advisory Council on Science and Technology also held a Discovery Roundtable in September 2005 on the use of government procurement to encourage innovation and the diffusion of technology by Canadian SMEs.

We considered proposals that would give Canadian firms an advantage in federal government purchasing, such as those in use in the U.S. However, we decided against recommendations in that area. Our view is that Canadian firms need to succeed because they meet the demands of the international market, not because they get advantages and protection at home. Nonetheless, the CPB may want to consider further options in this area.

Improving the Education System

Although this is clearly beyond federal jurisdiction, it may be appropriate to identify gaps in student skills that provinces and territories may want to address. This would reflect a commitment at their level to fostering excellence in a culture of commerce, and would support their overall economic development objectives. Based on the work of Nobel Prize-winning economist James Heckman, the Honourable Margaret Norrie McCain and J. Fraser Mustard have emphasized that early investments in learning are the most effective, as learning begets further learning, and the young have a longer time period to benefit from the fruits of these investments.[5]

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4. The Conference Board of Canada (Brian Guthrie and Trefor Munn-Venn on behalf of the Leaders' Roundtable on Commercialization), *Six Quick Hits for Canadian Commercialization* (Ottawa: The Conference Board of Canada, April 2005).
5. The Honourable Margaret Norrie McCain and J. Fraser Mustard, *The Early Years Study Three Years Later* (Toronto: The Founders' Network, Canadian Institute for Advanced Research, August 2002).

Appendix I

Commercialization Strategies Being Used in Other Countries[1]

Summary of Key Features of an International Model

Given that Commercialization Is Based on Risk Taking, Policies Must Encourage Such Risk Taking and Must Respect Constructive Failure

- Commercializing innovations – both science-based and other forms – is an inherently high-risk endeavour.
- Commercialization projects, by their nature, will not all be successful. A sound accountability framework will not focus unduly on the failure of individual projects, but will take a balanced, overall view of success and failure.

Successful Commercialization Should Allow the End Customer to Be a Driver of the Commercialization Process

- Although public research will sometimes lead to new technologies being developed, it is more common for downstream buyers and receptors to provide feedback that guides industry-oriented research and development (R&D) practices.

Education and Skills Development Are Critical Components of Commercialization

- Ongoing and lifelong learning to develop and enable a skilled workforce are critical components of a nation's commercialization capacity.
- Education in entrepreneurship and managerial skills is also critical to commercialization.
- The key barriers to successful commercialization are lack of skills and education, meaning that simply providing more money for SMEs is likely to lead to waste and limited returns.

Intermediary Organizations Are Important

- Suitable mechanisms must be developed to ensure that the outcomes of cooperative projects can be diffused. Such mechanisms should include the provision of technical staff to assist in implementing new technologies. This would be facilitated through the establishment of autonomous program leadership with sufficient responsibility to enable effective cooperation and overcome barriers to technology transfer.
- In general, technology transfer and commercialization offices tend to operate parallel to other economic development organizations.[2] This can mean a significant challenge, given that technology transfer is critical to technology development and is based on the sharing of knowledge and information.

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[1] The information in this appendix is based primarily on a review prepared by David Watters, President, Global Advantage Consulting Group, Inc., and David Brook, Principal, DBk Consulting, on behalf of Industry Canada for the Minister of Industry's Expert Panel on Commercialization and entitled "Commercialization – International Programs and Best Practices" (June 2005).

[2] Andrew Reamer, with Larry Icerman and Jan Youtie, *Technology Transfer and Commercialization: Their Role in Economic Development* (Washington: Economic Development Administration, U.S. Department of Commerce, August 2003), p. viii.

It Is Critical to Understand and Establish Appropriate Incentives for Researchers, Firms and Intermediaries

- Lack of, or even negative, incentives for academics (for instance, slower professional advancement) to become involved in commercialization activities is a major barrier to innovation in some countries (e.g. Sweden, France).
- At Stanford University, researchers receive one third of net royalties from licensing; University of California researchers receive about 35 percent.
- The impacts of positive, appropriate incentives for commercialization on the rates of innovation and commercialization in a country can be striking (e.g. Denmark, Finland).

Patent Reform and the Development of a Consistent System for Intellectual Property Management Are Critical Enablers of Technology Transfer and the Commercialization of Public Research

- Many countries are recognizing the importance of developing a community patent (similar to the U.S. system of patents for research supported by federal funding under the *Bayh-Dole Act*).
- Even the U.S., which is considered a world leader in intellectual property management, has expressed the urgent need to look at patent and intellectual property management reform.
- Knowledge and management of intellectual property rights are increasingly important for new technology firms.

The United States

The U.S. has a vast array of programs and initiatives that relate to commercialization and innovation. It also benefits from a set of securities, banking and bankruptcy laws that encourage risk taking and allow for graceful failure.

A recent study by Cohen, Nelson and Walsh showed that almost a third of industrial research projects in the U.S. make use of public research, more than a fifth make use of public instruments and techniques, and the impact of public research on industrial R&D is at least as great as that of R&D undertaken by rival firms in the same sector.[3] The study also pointed out that, although public research is critical to the development of firms in a small number of fields (e.g. biotechnology and pharmaceutical development), it is also moderately to very important to the development of firms in a wide range of other traditional and non-traditional sectors.

Another interesting finding is that, while public research sometimes leads to new technologies being developed, it is more common for feedback from downstream buyers and receptors to guide industry-oriented R&D. The authors found that in the U.S., despite programs such as Small Business Innovation Research, large firms are more likely and better able to use the results of public research than smaller firms. This is due to their larger R&D budgets and more highly developed research networks. Among smaller firms, it was noted that start-ups use public research much more than established SMEs do.

Cohen et al. concluded that the contribution of public research to industrial R&D is considerable and pervasive. The authors also suggested that broad, informal networks of communication between public R&D and the private sector are at least as important to successful commercialization as formal, cooperative research undertakings.

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[3] Wesley M. Cohen, Richard R. Nelson and John P. Walsh, "Links and Impacts: The Influence of Public Research on Industrial R&D," *Management Science* 48, 1 (January 2002): pp. 21–22.

Basic Data on Commercialization in the United States

- The private sector accounts for 70 percent of total R&D in the U.S.
- Industry supports 6–8 percent of total academic research in the U.S.
- The U.S. federal government accounts for US$32 billion of the applied R&D that could be considered good candidates for technology transfer.[4]
- In 2000, public research institutions in the U.S. produced 4200 inventions, 2100 patent applications and 1400 new patents.
- The National Institutes of Health has the most successful technology transfer program in the U.S. (US$52 million generated from 1700 licences in 2000). This program was instrumental in helping to create the U.S. biotechnology industry.
- Universities and colleges collected about US$830 million in royalties and other payments in 2001, mostly from a few blockbuster licences.[5] Of 23 000 active licences in 2001, only 131 generated more than US$1 million each in revenue.
- In general, venture capital firms have moved from risky to less risky investments (US$94 billion was invested in technology companies in 2000, compared with US$19 billion in 2002).
- U.S. laws for securities, banking and bankruptcy allow for graceful failure and provide a strong incentive for entrepreneurs to take risks.

Policy Bodies

President's Council of Advisors on Science and Technology

Originally established in 1990, this Council enables the President to receive advice from the private sector and the academic community on technology, scientific research priorities, and math and science education. Its current areas of detailed examination are nanotechnology (including its commercialization), advanced energy technologies and personalized medicine.

Membership

The Council consists of 23 distinguished persons appointed by the President, drawing from industry, industry associations, the education sector, research institutions and non-governmental organizations. The Director of the Office of Science and Technology Policy co-chairs the Council with one of the 23 appointees.

The Council's secretariat is the Office of Science and Technology Policy (Executive Office of the President), which provides administrative services to the Council.

Council on Competitiveness

The Council on Competitiveness has a broad action agenda of advising on policies that drive economic growth and raise the standard of living. Its findings also address commercialization issues.

Membership is composed exclusively of chief executive officers, university presidents and labour leaders. Council members work directly with the President's Council of Economic Advisors to raise the visibility of innovation issues.

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4. Magnus Karlsson, *Commercialization of Research Results in the United States: An Overview of Federal and Academic Technology Transfer* (Stockholm: Swedish Institute for Growth Policy Studies [ITPS], 2004), p. 7.

5. Ibid., p. 8.

Specific Commercialization Policies, Initiatives and Programs

The *Bayh-Dole Act* (1980)

The *Bayh-Dole Act* was designed to promote technology transfer by granting the intellectual property rights for research undertaken with federal funding to the institutions performing federal research. It is widely acknowledged to be a cornerstone of U.S. commercialization activities, leading to the establishment of some 2200 firms and adding US$30 billion to US$40 billion annually to the U.S. economy.[6]

The universities most successful at commercialization have been Stanford University, the Massachusetts Institute of Technology, Columbia University and the University of California. A major challenge is that an estimated less than one half of new technologies are disclosed by researchers in the U.S. Further, the best faculty are also the least likely to pursue commercialization.[7]

Stevenson-Wydler Technology Innovation Act (1980)

This Act established Offices of Research and Technology Applications at federal labs and authorized the National Science Foundation to help in the creation of centres for industrial technology at universities and other institutions. The Act also created the Office of Productivity, Technology and Innovation within the Department of Commerce, which was subsequently transformed into the Office of Technology Policy when Congress established the Technology Administration in 1988.

Technology Transfer Offices

All federal labs have technology transfer offices. The lack of skilled personnel is a huge barrier to the success of these offices as the nature and complexity of deals increase and their staff need to master increasing numbers of skills.

Small Business Innovation Research

Budget: US$2 billion of funding in 2004.

When created: Created under the *Small Business Innovation Development Act* in 1982.

Mandate/Objectives:

- Stimulate technological innovation.
- Use the small business sector to meet federal R&D needs.
- Foster and encourage participation in technological innovation by minorities and disadvantaged persons.
- Increase the private sector commercialization of innovations derived from federal R&D.

Main programs:

- The program has three phases:
  - I: US$100 000 (feasibility);
  - II: US$750 000 (prototype); and
  - III: private funding (market development).

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6. Ibid., p. 10.
7. Ibid., p. 10.

Small Business Technology Transfer Program

Budget: US$209 million of funding in 2004.

When created: In 1992 as a congressional pilot project.

Mandate/Objectives:

- Fund cooperative R&D projects that involve small business and a research institution (i.e. a university, a federally funded R&D centre or a non-profit research institution).
- Create an effective vehicle for moving ideas from national research institutions to the market.
- Focus on benefiting private sector and military organizations.

Main programs:

- The program has three phases:
  - I: US$100 000 up to 12 months (feasibility);
  - II: US$750 000 up to two years (prototype); and
  - III: private sector and/or military funding.

Small Business Administration

Budget: Requested US$593 million in 2006.[8]

When created: In 1953 under the *Small Business Act*.[9]

Mandate/Objectives:

- Improve the economic environment for small businesses.
- Increase small business success by bridging competitive opportunity gaps facing entrepreneurs.
- Restore homes and businesses affected by disaster.
- Ensure that all Small Business Administration programs operate at maximum efficiency and effectiveness by providing them with high-quality executive leadership and support services.

Main programs:

- The Office of Entrepreneurial Development is focused on training and counselling services, with a variety of programs focused on entrepreneurial and small business development.
- In its loan programs, Small Business Administration acts primarily as a guarantor of loans made by private and other institutions.
- The administration also offers contracting assistance programs.

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[8] U.S. Small Business Administration, *Congressional Submission Fiscal Year 2006 — Budget Request and Performance Plan* (www.sba.gov/cfo/2006_Budget_Request_and_Performance_Plan.pdf), p. 5.

[9] U.S. Small Business Administration, *Overview & History of the SBA* (www.sba.gov/aboutsba/history.html). Program information is taken from www.sba.gov/aboutsba/sbaprograms.html.

Small Business Investment Companies Program[10]

Budget: Delivered US$2.3 billion in funding in 2002, which provided venture capital to 2853 companies and represented 11 percent of all venture capital funding in the U.S. in 2002.

When created: 1958.

Mandate/Objectives:

- Fill the gap between the availability of venture capital and the needs of small businesses in start-up and growth situations.
- Offer small businesses equity capital, long-term loans and expert management assistance.
- Allow venture capitalists to supplement their own private investment capital with funds borrowed at favourable rates through the federal government.

Main programs:

- Just-in-time funding allows funds to be drawn down against outstanding commitments on a daily basis to meet investment/cash needs. The program had a 2004 leverage ceiling of US$116 million.

Cooperative Research and Development Agreements

These agreements between private sector and federal laboratories are an important vehicle for supporting commercialization of public research. Through these standard agreement templates, the performing companies retain the title to the inventions created through the funded research.

Business Incubators

In 2001, there were 950 active incubators assisting 35 000 start-ups and earning more than US$7 billion annually in the U.S.[11]

Industry-University Cooperative Research Centers and Engineering Research Centers

The 50 Industry-University Cooperative Research Centers and 20 Engineering Research Centers are administered by the National Science Foundation. The majority of funding for these come from partnering firms to support partnered approaches to new and emerging research areas.

Advanced Technology Program

Budget: US$153 million in funding in 2002.

When created: In 1990 by the Department of Commerce.

Mandate/Objective:

- A public–private partnership program that funds high-risk research to develop enabling technologies that have potential for commercial return.

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[10] See www.sba.gov/inv for more information on this program.

[11] Magnus Karlsson, *Commercialization of Research Results in the United States*, p. 8.

Procurement Programs

Examples of procurement programs include Project BioShield, in which the U.S. administration will invest US$6 billion in procurement money to develop and make available modern drugs and vaccines against chemical and biological weapons.[12]

Battelle Memorial Institute[13]

Budget: US$3 billion annually for R&D.

When created: 1929.

Mandate/Objectives:

- Provide solutions and develop innovative products for commercial customers by leveraging technology into competitive advantages.
- Provide government agencies with cost-effective science and technology (S&T) for national security, homeland defence, health and life sciences, energy and the environment, and transportation and space.

Main programs:

- Contract R&D provides S&T solutions to government and industrial customers.
- Laboratory operations currently manage four laboratories for the Department of Energy.
- Battelle Ventures, L.P. provides seed and early-stage equity capital for companies based on technologies that Battelle owns, manages or influences.
- The Institute also returns financial and volunteer resources to educational initiatives in operating communities, with a focus on science and math education.

Australia

A recent report by Allen Consulting Group included the following key findings on the commercialization of public sector research in Australia:[14]

- Australia has improved the turnover by companies from publicly funded research from A$300 million in 1983 to A$1.5 billion in 2002.
- Australia is closing its commercialization gap with the rest of the world.
- A couple of hundred Australian SMEs have emerged from publicly funded research, including a limited number of stars and solid performers.
- These stars tend to be based on cutting-edge technology, while the solid performers can be based on incremental research and a supportive commercialization environment.
- Investments in the R&D system have not yet fully paid off for Australia.
- Policy-makers need to take a longer-term and consistent approach to commercialization.
- It is important to have a balance between support for research and support for commercialization.
- Outcome measurement and monitoring is quite difficult at present.

Australia has an innovation framework titled Backing Australia's Ability – Building Our Future through Science and Innovation. This framework aims to build a world-leading innovation and commercialization system. The strategy was funded at A$3 billion in 2001, and this funding was extended in 2004–2005 by A$5.3 billion over seven years. As part of the strategy, Australia introduced a number of programs, including a graduate program in entrepreneurship and the Australian Institute for Commercialisation.

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12. Ibid., p. 12.

13. Battelle Memorial Institute, *Change: Battelle Annual Report 2003* (www.battelle.org/annualreports/ar2003/default.htm).

14. The Allen Consulting Group on behalf of the Australian Institute for Commercialisation, *The Economic Impact of the Commercialisation of Publicly Funded R&D in Australia* (Eight Mile Plains: Australian Institute for Commercialisation, September 4, 2003): p. 3.

Policy Bodies

Prime Minister's Science, Engineering and Innovation Council

Formed in December 1997, this Council is the Australian government's principal source of independent advice on issues of science, engineering, innovation and relevant aspects of education and training.

To underpin its advisory role, the Council examines Australia's science and engineering capabilities and the effectiveness of their organization and use. The Council's non-ministerial members constitute its standing committee and oversee and contribute to studies and research aimed at improving understanding of major science, engineering and innovation issues.

Membership

Ministerial membership of the Council is made up of 10 ministers of the Crown, chaired by the Prime Minister. The Deputy Chairs are the Deputy Prime Minister and Minister of Trade. The ex officio membership is made up of 14 members, largely drawn from academic, business, professional association (engineer) and science organizations. Members appointed in their personal capacities include six industry and academic leaders.

The Council's standing committee meets four times per year, with most work undertaken through working groups of members and co-opted outsiders.

The Council's secretariat is part of the Department of Education, Science and Training.

Specific Initiatives

Australian Institute for Commercialisation

Budget: A$11.2 million over five years.

When created: 2002.

Mandate/Objectives:

- Coordinate commercialization activities on a national scale.
- Respond to areas of market failure.

Main programs:

- The Australian Institute for Commercialisation (AIC) has three main programs:
  - AIC Connect has eight program areas to coordinate and leverage existing commercialization expertise.
  - AIC Know-How is made up of six initiatives to improve the level of knowledge and skills development in the management of the commercialization process.
  - AIC Assess has two initiatives to measure the outcomes of R&D.

Building on Information Technology Strengths (BITS) Incubator Program

Budget: A$78 million over four years.

When created: Initial funding in 1999–2000 (pilot ended in 2004).

Mandate/Objectives:

- Establish 10 business incubators focused on information and communications technologies in cities across Australia.

Main programs:

- BITS Incubators help start-up businesses commercialize R&D and reach a stage in the development of their business where they can attract investment to support further growth. BITS Incubators assist in the development of business plans and marketing strategies and provide start-up and seed funding. In return for these services and investment capital, BITS Incubators take equity in the firms that they assist.
- In 2004, a further A$36 million was provided under the ICT Incubators Program to support the better-performing incubators previously funded under the program for an additional four years.

Commercial Ready Program[15]

Budget: The Commercial Ready Program provides A$200 million a year to SMEs, in grants from A$50 000 to A$5 million.

When created: In 2004, to operate until 2011.

Mandate/Objectives:

- Encourage the growth and successful innovation of Australian companies by increasing the level of research and development, proof-of-concept and early-stage commercialization by Australian businesses.
- Assess eligible applications against the following five criteria:
  - management capability of the applicant;
  - commercial potential of the project;
  - technical strength of the project, and technical capability and resources available to the applicant;
  - extent to which the project is likely to provide national benefits; and
  - need for funding.

Pre-Seed Fund[16]

Budget: The Australian government provided A$72.7 million of capital to four Pre-Seed Funds. Private sector investors will bring the total budget up to A$100 million.

When created: Reformatted in 2003 to broaden the ability of cooperative research centres to be eligible for the program.

Mandate/Objectives:

- Establish early-stage venture capital funds to invest in projects or companies spinning out from universities or government agencies.
- Encourage the private sector to take a more active role in funding and managing the commercialization of research.

Main programs:

- The four venture capital funds invest in projects or companies spinning out from universities or government agencies. The funds are managed by venture capitalists experienced in research commercialization and the development of sustainable businesses. The maximum investment in any project or company is A$1 million.

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[15] See www.printnet.com.au/pages/business_solutions/government_services_sub_pages/commercial_ready_program.html.

[16] For details, see "Pre-Seed Fund" under "AusIndustry Products" at www.ausindustry.gov.au.

Japan

Policy Bodies

Council for Science and Technology Policy

Founded in January 2001, this Council advises the Prime Minister and Cabinet on overarching matters relating to S&T. The Council formulates basic S&T policies, allocates human and budget resources, and evaluates large-scale R&D proposals from the ministries that are of national significance or are expected to cost over US$280 million.

The Council meets monthly with the Prime Minister and has weekly policy-steering meetings.

Membership

The Council is made up of 14 members, of which government cannot account for more than half. The Prime Minister is the Chair. Other government members include the Chief Cabinet Secretary, the Minister of State for Science and Technology Policy, other relevant Cabinet members as designated by the Prime Minister, and heads of relevant government agencies (e.g. the President of the Science Council of Japan), as designated by the Prime Minister.

Executive members must not account for less than half of the total membership and must be persons of superior knowledge and insight concerning S&T.

Europe

The following is a basic data set regarding technology transfer institutions in 15 European Union countries.[17]

Number of technology transfer institutes:	1219
Embedded:	53 percent
Wholly owned:	14 percent
Independent:	33 percent

Technology transfer institute activities include:

- patenting;
- licensing of intellectual property rights;
- liaison for contract research;
- support of spinoffs including business services; and
- financing of spinoffs.

Specific European Commercialization Programs and Initiatives

European Business and Innovation Centres Network

Budget: Information not available.

When created: In 1984 by the European Commission.

Mandate/Objectives:

- Promote the growth of Business and Innovation Centres (BICs), both within and outside the European Union.
- Set up new SMEs and/or new activities within existing SMEs based on new ideas that have growth potential.
- Facilitate communication and partnership among BICs.

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[17] European Commission, DG Enterprise, *Technology Transfer Institutions in Europe: An Overview* (Brussels: European Commission, DG Enterprise, January 2004), p. 21.

Main programs:

- The mission of this organization is to promote the growth of BICs in order to support the creation and expansion of SMEs. To this end, the network provides a range of services, including technical assistance, risk analysis and business plan support.

Sixth Framework Programme

Budget: €17.5 billion (€1 = ~C$1.50) between 2003 and 2006.

When created: Proposed by the European Commission and adopted by The Council of the European Union in 2002.

Mandate/Objectives:

- Create the European Research Area as a vision for the future of research in Europe.
- Focus on progressive integration of European research activities.

Canada can participate in the program's projects, but must provide its own funding.

EUREKA

Budget: Funded nationally on an individual-project basis.

When created: In 1985 as a European intergovernmental initiative.

Mandate/Objectives:

- Enhance European competitiveness through support to businesses, research centres and universities that carry out pan-European projects to develop innovative products, processes and services.
- Offer project partners rapid access to a wealth of knowledge, skills and expertise across Europe.
- Facilitate access to national public and private funding schemes.

Main programs:

- EUREKA clusters are long-term, strategically significant industrial initiatives that bring together large companies, SMEs, research institutes and universities, sharing both the risks and benefits of innovation. The clusters focus on developing and commercially exploiting new technologies in information technology, medicine, robotics, energy and communications.
- EUREKA umbrellas are thematic networks within the EUREKA framework that focus on specific technology areas or business sectors. The main goal of an umbrella is to facilitate the generation of EUREKA projects in its own target area. EUREKA umbrellas focus on the information technology, medicine, robotics, environmental, transportation and laser sectors.

Finland

Finland is now considered to be one of the real success stories in terms of its national innovation and commercialization initiatives. However, it is useful to examine what the drivers were for the development of Finland's current S&T ecosystem:[18]

- selecting the right technologies and appropriate levels of funding, and avoiding the dispersal of promotion efforts;
- developing suitable mechanisms to ensure that the outcomes of cooperative projects can be diffused, including providing technical staff to give assistance in the implementation of new technologies (this is facilitated through the establishment of autonomous program leadership with sufficient responsibility to allow effective cooperation and overcome barriers to technology transfer);
- encouraging cooperation between industry and research enterprises in order to address the increasing risk of applied research arising from increases in the levels of investment necessary to foster innovative research and shorter product life cycles;
- establishing clear authorities in technology transfer for both academic or research and industrial or enterprise organizations;
- addressing the low absorption rate of technology in enterprises by looking at and addressing key challenges, such as a lack of skilled workers, organizational bottlenecks, etc.; and
- acknowledging that communications technologies can play a predominant role in the rate of technology diffusion.

The key message from P. Okko and A. Gunaskekaran's article "An Analysis of Technology Transfer and Diffusion as a Part of Growth Strategy" was that technology transfer is not a passive activity, but one that requires active communication and an active adopter.

Policy Bodies

Science and Technology Policy Council of Finland

This Council directs S&T policy, makes such policies nationally compatible, and prepares relevant plans and proposals. In addition to an executive committee, the Council has a science policy subcommittee and a technology policy subcommittee. These are chaired by the Minister of Education and Science and by the Minister of Trade and Industry, respectively.

Membership

Membership includes seven ministers, chaired by the Prime Minister. The Deputy Chairs are the Minister of Education and Science and the Minister of Trade and Industry. There are also 10 members appointed by government and largely drawn from among business, trade union and academic leaders. In addition, the Council includes five permanent experts who are senior officials of government.

The Council's secretariat consists of two full-time chief planning officers drawn from government for three-year terms.

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[18] Paavo Okko and A. Gunaskekaran, "An Analysis of Technology Transfer and Diffusion as a Part of Growth Strategy," *International Journal of Technology Management* 12, 4 (1996): pp. 477–487.

Specific Initiatives

VTT Technological Research Centre of Finland[19]

Budget: External income in 2004 was €151.1 million, including €67.2 million from the private sector, €52.7 million from the domestic public sector and €31.3 million from foreign investors.

When created: Over 60 years ago (in the 1940s).

Mandate/Objectives:

- Act as a contract research organization providing a wide range of technology and applied research services for its clients, private companies, institutions and the public sector.

Main programs:

- The Centre conducts research in six main areas: electronics, information technology, industrial systems, processes, biotechnology, and building and transport.

Tekes[20]

Budget: €400 million, funding 2000 projects annually.

When created: 1983.

Mandate/Objectives:

- Promote the competitiveness of Finnish industry and the Finnish service sector by technological means. Activities aim to diversify production, increase production and exports, and create a foundation for employment and societal well-being.

Main programs:

- Tekes targets new technology-based firms and SMEs, as well as new business and international cooperation. Selection is based on an alignment of global trends and Tekes objectives. There are a number of technology transfer institutions located in Finnish technology parks; these are jointly owned by universities, regional development organizations and the national fund for R&D.

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[19] See www.vtt.fi.

[20] See www.tekes.fi/eng.

France

Until 1999, only public sector research enterprises had their own technology transfer offices. After 1999, universities started to establish their own technology transfer offices. In 1992, the National Centre for Scientific Research created a subsidiary program, France Scientific Innovation and Transfer, to address issues of commercialization and technology transfer. There are also a number of regional technology transfer institutions focused on French SMEs.

Specific Initiatives

OSEO anvar[21]

Budget: €289 million annually.

When created: 1981.

Mandate/Objectives:

- Promote and finance innovation in French industry, particularly among SMEs.
- Facilitate the emergence of new products and processes in all fields of activity.

Main programs:

- Personalized assistance offers engineering and assistance services to new SMEs and start-ups.
- Financial instruments include repayable contributions and equity capital to spread the risk.
- Customized funding is aimed at encouraging growth through innovation by providing help in getting funding through venture capitalists, angel investors and other funding bodies.

Germany

In many ways, Germany is an exception to the general rule that European nations have not embraced commercialization initiatives until very recently. Moreover, Germany recently introduced a change in legislation so that intellectual property rights are now owned by the institution that develops them, not the individual researcher. This innovation has had far-reaching consequences for commercialization in Germany. Similar changes in patent laws have occurred recently in Denmark, Finland and Norway.

Specific Initiatives

Garching Innovation GmbH

Founded in 1970, this organization is a subsidiary of the Max Planck Society and is responsible for the commercial exploitation of Max Planck patents. Garching has the largest portfolio of start-ups in Germany.

Ascension GmbH

Another subsidiary, this organization belongs to the four Helmholtz institutions responsible for the management of intellectual property relating to biotechnology.

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[21] See www.oseo.fr/oseo/filiales_metiers/oseo_anvar (in French only).

Fraunhofer-Gesellschaft[22]

Budget: €1.1 billion.

When created: 1955.

Mandate/Objectives:

- Undertake applied and strategic R&D of direct benefit to the private and public sectors, and society as a whole.

Main programs:

- Fraunhofer-Gesellschaft maintains roughly 80 research units, including 58 Fraunhofer Institutes, with a staff of 12 500 (predominantly made up of scientists and engineers). Roughly two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. The remaining one third is contributed by the German federal and lander (federal state) governments to pursue research that is more fundamental. Fraunhofer-Gesellschaft also has affiliated research centres and representative offices elsewhere in Europe, as well as in the U.S. and Asia.
- The Fraunhofer-Patentstelle für die Deutsche Forschung patent centre maintains services for three types of clients: companies, universities and technical colleges, and inventors. Its services include:
  - financially promoting inventions;
  - cooperating with research facilities and universities in the use of intellectual property rights; and
  - assessing and evaluating inventions, patents and technologies.
- The German government has also established 22 Patent Valorisation Agencies to commercialize research results on behalf of a number of universities, colleges and other public and private research facilities.

Ireland

Policy Bodies

Advisory Council for Science, Technology and Innovation[23]

Established in May 2005 to succeed the Irish Council for Science, Technology and Innovation (ICSTI), the Council's role is to:

- act as the primary interface between stakeholders and policy-makers, contributing to the development and delivery of a coherent and effective national strategy; and
- advise government on medium- and long-term policy for science, technology and innovation.

In accordance with its annual work plan, and in response to any specific requests from the government, the Council provides its advice to government through an Inter-Departmental Committee on Science, Technology and Innovation. The Council's work program is agreed upon in conjunction with the Inter-Departmental Committee in order to ensure the necessary coherence across the science, technology and innovation policy system. The Council may agree to establish mechanisms, such as task forces, to move elements of its work program forward.

The Council is one element of the structures put in place upon the recommendation of a December 2002 ICSTI Commission report on the Overarching Framework for Science, Technology and Innovation. Other elements include a dedicated Cabinet Committee, supported by a high-level Interdepartmental Committee, and the appointment of the government's first Chief Science Advisor.

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22. See www.fraunhofer.de.

23. See www.sciencecouncil.ie.

Membership

There are 12 members of the Council, including an independent Chair. No less than four members can be from the academic sector, and no less than four can be from the business sector. There is also a representative from Forfás (Ireland's national policy advisory board for enterprise, trade, science, technology and innovation), which operates under the auspices of the Department of Enterprise, Trade and Employment.

The Chief Science Advisor has the right to attend all meetings of the Council, and representatives from the Department of Enterprise, Trade and Employment are normally invited as observers. Representatives from other relevant government departments may also be invited to attend as observers.

The Council's secretariat is provided by Forfás.

Specific Initiatives

Enterprise Ireland[24]

Mandate/Objectives:

- Help Irish companies to grow and sustain positions in global markets that are producing innovative, high-value products and services.

Main programs:

- Activities are focused in five main areas:
  - Achieving export sales.
  - Investing in research and innovation.
  - Competing through productivity.
  - Starting up and scaling up.
  - Driving regional enterprise.
- Enterprise Ireland supports R&D projects under its Research Technology and Innovation (RTI) program and provides tailored support for large-scale R&D funding requirements. To solve technical challenges faced by Irish industry, Enterprise Ireland also works with a number of industry sector groups to stimulate industry-led research programs.
- The Innovation Partnerships Initiative provides financial support to encourage companies to undertake research projects with Irish universities and institutes of technology.
- To help bring technology from the research setting to market, the Commercialisation Fund provides support for applied research at the proof-of-concept phase, technology development phase and business development phase.
- Enterprise Ireland can support participation of Irish organizations in the EU Framework Programme for R&D, as well as the EUREKA and the European Space Agency programs.
- Enterprise Ireland also maintains an overseas network of 33 international offices to provide a gateway to Ireland for international companies that are looking for world-class suppliers.
- The Irish Innovation Relay Centre[25] (IRC), one of 71 IRC Centres throughout Europe, links Irish companies with European partners who are interested in exploiting technology opportunities. Technology transfer consultants review the technology needs of individual firms and provide access to a European database of technology solutions (offers and requests). Enterprise Ireland's IRC facilitates group missions to industrial clusters and major industrial fairs throughout Europe, and holds seminars and training in technology transfer. The IRC also provides support to Irish companies involved in research projects under the European Framework Programmes.

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[24] See www.enterprise-ireland.com/AboutUs.

[25] See www.irc-ireland.ie/about.asp.

Campus Companies Venture Capital Fund

This national fund makes funding available to staff and recent graduates of Irish universities to help them establish companies out of the knowledge they gained doing university research. The companies formed share the intellectual property on a 50-50 basis with their home universities.

Shannon Development

Shannon Development supports the establishment of new, and the development and expansion of existing, industrial and internationally traded service firms in Ireland's Shannon Region, placing particular emphasis on the development of high-potential firms within the knowledge economy. Grants and loans in the range of £100 000 to £1 million are provided, with Shannon Development often acting as a first or lead funder on a project. It claims to spend 5 percent of its time evaluating projects and making funding decisions and 95 percent working to make sure the companies they fund are successful. The organization measures success in profitable sales, export and employment, in that order.

Fusion

Fusion is InterTradeIreland's all-island technology transfer initiative that gives companies (mainly SMEs) access to the expertise and facilities in colleges and universities across the island of Ireland. This initiative develops and facilitates three-way partnerships and projects among companies, academic institutions and graduates to promote strategic advances in innovation and technical capability.

The Netherlands

Policy Bodies

Advisory Council for Science and Technology Policy

Originally established in 1990, the Council advises the Dutch government and Parliament on S&T policy, both in a national and international context, and provides information related to S&T, including advice on medium- and long-term policy.

The Council may issue advice in response to requests by the Minister of Education, Culture and Science; the Minister of Economic Affairs; the Lower House of the Dutch Parliament; or on its own initiative.

The Council operates independently of both ministries.

Membership

The Council is composed of a maximum of 12 members drawn from various sectors, including education/knowledge institutions and industry. Members are appointed on the recommendation of the Minister of Education, Culture and Science, and the Minister of Economic Affairs, each of whom recommends half the Council. Members of the Council are appointed in a personal capacity and, therefore, do not represent any vested interests. They are appointed for a period of four years, which can be extended twice.

The Council's secretariat consists of a secretary / office director and about six scientific and eight support staff. The secretariat also supports an information centre and is independent of the operating ministries of government.

The Innovation Platform

The core impetus for establishing the Innovation Platform in August 2003 was the view that the Netherlands was not using its economic and human potential as effectively as it could. The platform proposes measures to fully employ this potential and targets a wide range of policy issues. The platform discusses how to increase cooperation between knowledge institutions and companies, promote innovation in education and the public sector, create a more favourable climate for entrepreneurs and knowledge workers, and increase the Netherlands' appeal to international talent.

Five working groups are in place to address each of the following specific issues: dynamics of the Dutch innovation system, long-term choices, moving up in higher education, consultation groups, and innovation in public governance. A working group on international knowledge workers has already published its results.

Membership

The 18 members of the Innovation Platform are drawn from various sectors and include heads of education/knowledge institutions, industry chief executive officers and government ministers. The Prime Minister chairs the Platform.

The Innovation Platform is supported by an implementation office, which is in charge of project management and provides general support.

Sweden

A recent study by Goldfarb and Henrekson highlighted the differences in effectiveness between the Swedish and U.S. approaches to technology transfer.[26] Although Sweden's relative spending on R&D has been the highest in the world for more than a decade, the performance of its academic start-ups has been weak. The authors of the study argue that this is because of a lack of incentives for academics to become involved in the commercialization process. In 2002, only 11 of 47 universities in Sweden had subsidiaries that managed patenting and the commercialization of intellectual property rights.

Policy Bodies

Swedish Government Research Advisory Board

Established in 1962, this Board encourages closer cooperation among researchers, technologists, industrialists and the government. It has also helped to establish a constructive dialogue between researchers and political decision-makers on both scientific development and the shaping of research policy.

Membership

The Board has 14 members and is headed by the Minister of Education and Science. The Board's members represent different parts of the research, academic and business communities.

The researchers on the Board are active in a broad range of scientific disciplines and include representatives of both large and small knowledge-intensive businesses. The Board is not a decision-making body but nevertheless plays an important role as an advisory body to the Swedish government on research policy issues.

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[26] Brent Goldfarb and Magnus Henrekson, *Bottom-Up vs. Top-Down Policies towards the Commercialization of University Intellectual Property*, SSE/EFI Working Paper Series in Economics and Finance No. 463, February 25, 2002, p. 29–31.

Specific Initiatives

VINNOVA – Swedish Governmental Agency for Innovation Systems[27]

Budget: SEK 1 billion (SEK 1 = ~C$0.15) annually.

When created: 2001.

Mandate/Objectives:

- Promote sustainable growth by financing problem-oriented R&D and developing effective innovation systems.

Main programs:

- VINNOVA promotes innovation in 18 priority growth areas. It also supports R&D in more generic knowledge fields, with initiatives in five knowledge platforms – biotechnology, efficient product development, learning and health in working life, implementation of information and communications technologies, and infrastructure and efficient transport systems – that generate knowledge in order to benefit not only the 18 growth areas, but the economy and society as a whole.
- The Swedish Competence Centres Programme encourages linkages between public and industrial R&D needs and research in universities. A new initiative seeks to establish Competence Centres outside of universities, with the objective of concentrating Swedish research efforts in priority areas and increasing collaboration among the research institutes and other key actors in the Swedish innovation system (universities, industry and the community).
- VINNOVA and the Swedish Foundation for Strategic Research finance the VINST program (research cooperation for smaller high-tech companies), which provides grants for research projects conducted in collaboration between university researchers and SMEs. Projects are assessed by the quality of the science as well as commercial potential.

Swedish Industrial Development Fund[28]

Budget: Operates as a self-financing foundation (no ongoing government funding); current equity of about SEK 3.2 billion.

When created: Established as a foundation by the Swedish government in 1979.

Mandate/Objectives:

- The fund provides loans and equity finance to innovative, fast-growing companies that have strong export potential and strong management teams.

Main programs:

- Investments are made at the start-up, development and early expansion phases of companies, mainly in syndication with other venture capitalists. Business is conducted in four business areas: information and communications technologies, industry/energy, life sciences and indirect investments. The latter business area is responsible for the Fund's holdings in 11 venture capital companies around the country. Investments are also made in seed companies in partnership with universities and technical institutions around the country.

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[27] See publiceng.vinnova.se.

[28] See www.industrifonden.se/in%5Fenglish.

The Knowledge Foundation[29]

When created: 1994.

Mandate/Objective:

- The Knowledge Foundation supports business-relevant research at the new university colleges established in Sweden in the 1990s.

Main programs:

- The Knowledge Foundation invests for up to six years in research programs at university colleges in partnership with private consortia. Companies must provide matching funds.
- The Foundation contributes up to half of the financing for individual research projects in university colleges that are relevant to trade and industry, with the business community providing matching funds.
- The Foundation's post-graduate programs provide funding for doctoral students at small companies, allowing Swedish companies to hire more people who have advanced university degrees.

The United Kingdom

Policy Bodies

Council for Science and Technology[30]

The Council for Science and Technology (CST) was relaunched in 2004 with new terms of reference, a new membership and a "new way of thinking." It is the U.K. government's top-level advisory body on S&T issues, and submits its reports to the Prime Minister on strategic issues that cut across the responsibilities of individual government departments. The CST organizes its work around five broad themes (research, science and society, education, science and government, and technology innovation), and takes a medium- to longer-term approach. The CST can choose to deliver its advice to government through various routes, including published reports; confidential written advice; and discussions with ministers, officials and special advisors.

The CST's innovation subgroup shares information and informally exchanges views with the Technology Strategy Board (see the following).

Membership

Membership is made up of 2 Co-Chairs and 15 independent Directors. One of the Co-Chairs is the U.K. government's Chief Scientific Advisor; the other is elected from among the CST's independent members. The independent Chair presides over meetings when the CST is developing its views, but the Chief Scientific Advisor chairs when advice is reported to government.

The CST work program is developed by its members in discussion with government. Although the government can ask the CST to consider particular issues, the CST is under no obligation to agree to these requests.

The Minister for Science and Innovation is responsible to the Ministerial Committee on Science and Innovation for the CST's overall work program and effectiveness. The CST secretariat must be impartial and respect the CST's independence. Its tasks include networking with government officials on behalf of the CST, and seeking help with the CST's work program from a range of sources, both within and outside government.

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[29] See www.kks.se/templates/StandardPage.aspx?id=84.

[30] See www.cst.gov.uk.

Technology Strategy Board

The Technology Strategy Board, comprising mainly experienced business leaders, identifies the new and emerging technologies that are critical to the growth of the U.K. economy and into which government funding and activities can be directed. The Board prepares an annual report for publication on its own activities and on government priorities that relate to technology innovation and knowledge transfer. Advice from the Technology Strategy Board is used to identify priorities for the Department of Trade and Industry (DTI) Technology Programme.

The creation of a technology strategy was announced in the December 2003 *Innovation Report — Competing in the Global Economy: The Innovation Challenge*. The report proposed high-priority government action to encourage businesses to develop and implement new products and services by promoting technological innovation.

The report also proposed developing a technology strategy with a medium- to long-term perspective to provide a framework for setting policy priorities and improving the effectiveness of DTI support to businesses. Over time, the government's aim is for the business-led, market-focused DTI technology strategy to influence those actions across government that seek to improve technological innovation in business. The plan forms a key element of the government's *Science & Innovation Investment Framework 2004–2014*, published in July 2004.

Membership

Board membership is made up of 10 members external to the DTI, including 6 business people, 2 venture capitalists (with interests in technology sectors), 1 member of a regional development agency or devolved administration, and 1 research council chief executive.

The Chair is drawn from among the business people on the Board. Additional members may be recruited as necessary.

Membership also includes five DTI and other government department representatives, including the Director General, Innovation Group (DTI); the Director General, Business Group (DTI); the Chief Economic Advisor and Director General, Economics (DTI); the Director General, Research Councils; and one representative of other government departments.

Other DTI officials normally also attend meetings on an ex officio basis.

A secretariat supports the work of the Board and its relationship with stakeholders, drawing on the resources of the DTI's Innovation Group.

Specific Initiatives

Small Business Research Initiative[31]

Budget: Seeks to purchase €50 million of government research from small firms.

When created: The U.K. government announced in July 2000 that targets would be set for participating departments to procure a portion of their R&D needs from SMEs.

Mandate/Objectives:

- Provide opportunities to small firms whose businesses are based on providing R&D.
- Encourage other small businesses to increase their R&D capabilities and capacities.
- Create opportunities for starting new technology-based or knowledge-based businesses.

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[31] See www.sbri.org.uk/aboutus.php.

Department of Trade and Industry

Based on a 2002 review of programming, the DTI implemented 10 tailored products under 4 major groups to support innovation and SMEs, including the following:

- Succeeding through innovation with:
  - Knowledge Transfer Networks, which provide grants to intermediaries to set up networks in priority technology areas and bring together public and private sector organizations;
  - collaborative R&D, which provides funding for collaborative R&D projects;
  - Investigating an Innovative Idea, a reimbursed consultancy program to provide businesses with advice on implementing new innovations;
  - R&D grants to help businesses carry out R&D that could lead to technologically innovative products, services or processes; and
  - Knowledge Transfer Partnerships grants to cover part of the cost of using a person to transfer and embed knowledge in a business via a strategic project.
- Achieving best practices in business through:
  - grants to intermediaries to develop and disseminate best practices; and
  - a free diagnostic run by a Business Link advisor that provides support to implement best practices.
- Raising capital through:
  - the Small Firms Loan Guarantee, which provides a government guarantee that covers 75 percent of loans from financial institutions; and
  - Enterprise Capital Funds, which use soft loans to leverage capital.
- Regional investment through:
  - Selective Financing for Investment in England, providing financial assistance for firms to invest in assisted areas.

Technology Programme

The Technology Programme is the combination of business support products and information that the DTI offers business in response to advice from the Technology Strategy. Instead of focusing on technology sectors, the program focuses on supporting research into potential big-breakthrough, disruptive technologies. Over the period 2005–2008, £320 million is available to businesses in the form of grants to support R&D in the technology areas identified by the Technology Strategy Board. The program is delivered through two DTI business support products: Collaborative Research & Development, and Knowledge Transfer Networks.

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Appendix J

Executive Round Tables

In order to ensure that the academic and policy research carried out for the panel was grounded in the reality of those working in commercialization day-to-day, round-table discussions were held in several venues across Canada – in Vancouver, Edmonton, Saskatoon, Winnipeg, Toronto, Montréal, Moncton, Halifax and St. John's. Participating executives were selected to ensure that the widest range of views was represented. To stimulate discussion, some round tables were made up of executives who focused mainly on one part of the commercialization challenge. What follows is a summary of the views expressed at the round tables across the country.

Summary of Key Points Raised at Round Tables[1]

Talent

- Improved cross-fertilization is necessary between business and universities.
- German-style, three-year sabbaticals in industry or Swedish-style cross-appointments of scientists in firms and university departments may help.
- Similar sabbaticals or appointments for undergraduate and graduate students that place interns with mentors may also help.
- These exchanges are needed to bridge the culture gap between the business and university sectors and provide up-to-date knowledge and understanding of corporate needs.
- Businesses need to be able to locate and access university-based highly qualified personnel much more easily. Universities should focus on liaisons, not technology transfers.
- Having highly qualified personnel in management, especially marketing, is necessary; this is needed not just for firms that produce services or products, but also in capital markets, especially the angel and venture capital sectors. Multidisciplinary (e.g. engineering-marketing) programs are needed to bridge this gap.
- The federal government needs to focus on attracting and keeping foreign graduate students and other highly qualified personnel through immigration, repatriation (especially for graduates who have emigrated to the U.S.) and acknowledgement of foreign credentials.
- PhD graduates working in Canada earn less than those working in the U.S., and, in this sense, are a bargain for Canadian employers. However, the average wage of PhD graduates working in Canada is considerably higher than that of PhD graduates working in India or China.
- Canada needs more highly qualified personnel who understand business cultures and climates abroad.
- Canada needs more college graduates, as they are more likely to be technically oriented and well rounded.

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[1] This summary draws on all the round tables. Most of the points were raised, in one way or another, in more than one session. For the most part, the points represent consensus positions. In a few cases (e.g. federal investment in public R&D), a minority disagreed.

Research

- Canada needs to find a way to set priorities for its research and focus its resources. The research is now spread too thinly to be successful. There should be some consideration paid to business relevance in funding research at university and government labs (i.e. more industrial, less issue-oriented). Efforts to promote global success in research fields must be enhanced.
- Funding programs (such as the Industrial Research Assistance Program and Technology Partnerships Canada) should be structured so that the full range of benefits produced (e.g. jobs, taxes) are measured and reported. There is currently too much attention paid to the need for repayment, and to program objectives that reflect the reporting requirements of the bureaucracy.
- Research and development (R&D) tax incentives – such as the Scientific Research and Experimental Development (SR&ED) tax incentive program – need to be simplified and work more quickly.
- Funding and tax programs should cover a greater range of scientific activities, sustaining development efforts much further into the product life cycle.
- Federal investments in public R&D (i.e. at university and government labs) should be maintained and expanded. When appropriate, support should extend closer to commercialization. Businesses see this as valuable, even though not all of the benefits would be relevant to business.
- The federal government should develop an equivalent to the U.S. Small Business Innovation Research program, based on excellent science and peer review.
- University–business partnerships (e.g. the Medical and Related Science Discovery District project in Toronto) and fourth-pillar organizations that bring together business, government and post-secondary education institutions should be encouraged to identify opportunities. The federal government should work with existing clusters and develop incubators.
- Although there are trade-offs, university–industry liaison / technology transfer offices should expand their partnerships and the value they bring rather than focus on protecting and profiting from intellectual property (which is important but too narrow).

Capital

The federal government should:

- make SR&ED tax credits available to firms that are not currently able to use them;
- strengthen the availability of angel/local capital, perhaps by offering a tax credit (e.g. see the proposal from the Canadian Task Force on Early Stage Funding), creating local/regional pools (some provincial programs have been successful with this) or acting as a co-investor;
- improve the transition from one financing stage (e.g. seed, angel, venture, mezzanine, initial public offering) to the next (i.e. exit strategies);
- impose greater consequences on labour-sponsored venture capital corporations if performance requirements are not met;
- improve the environment for risk capital (e.g. through free trade in capital, the positions of institutional investors, and pension funds);
- complement tax and funding approaches with loans that impose greater accountability on firms;
- strengthen firms' abilities to present business cases to venture capital funds, through training and experience (see also "Talent" in the preceding); and
- maintain the consistency and continuity of programs, as they must survive changes in government.

Other

- Private sector involvement needs to be maintained in guiding innovation and/or commercialization programs.
- Canada needs to build a culture of commerce and leadership that celebrates success and values the wisdom gained from failure.
- Firms are "born global," and government programs need to reflect and address this (e.g. through renewal of the Program for Export Market Development and through trade mission qualifications).
- To achieve global success, firms need a domestic base. Government procurement, including government as the first user, is one key to establishing this base. The development of receptor firms – domestic customers that have strong foreign market presence that will embed new technologies/products – is also key.
- Compared with other countries, the Government of Canada should be the best and fastest authority for regulatory approval processes.
- The federal government should allow markets to choose winners and recognize that advantage is created as often as it is natural.
- The federal government should strengthen its intellectual property regime and harmonize it and its tax treatment with that of the U.S.

Appendix K

Stakeholder Submissions

As members of the Expert Panel on Commercialization, we received submissions from many stakeholders. We acknowledge that our work has been informed by the extensive amount of material available from previous and ongoing consultations on this and related topics, such as innovation. In addition to reinforcing and at times challenging our views, this input helped highlight areas where future work is required.

We would like to acknowledge contributions from the following organizations:

- Association of Canadian Academic Healthcare Organizations
- Association of Canadian Community Colleges
- Association of Canadian Polytechnic Institutes
- Association of International Automobile Manufacturers of Canada
- Automotive Parts Manufacturers' Association
- BIOTECanada
- Business Development Bank of Canada
- Canada Foundation for Innovation
- Canada's Research-Based Pharmaceutical Companies (Rx&D)
- Canada's Venture Capital & Private Equity Association
- Canadian Advanced Technology Alliance
- Canadian Automotive Partnership Council Innovation Working Group
- Canadian Construction Innovation Council
- Canadian Health Industries Partnership
- Canadian Institutes of Health Research
- Canadian Vehicle Manufacturers' Association
- CANARIE Inc.
- CMC Microsystems
- The Conference Board of Canada
- Doyletech Corporation
- Environmental Services Association of Alberta
- General Motors of Canada Limited
- GPT Management Ltd. (Dr. Alan Cornford)
- Greater Saskatoon Chamber of Commerce and the Enterprise Committee
- The Impact Group
- Information Technology Association of Canada
- Intellectual Property Institute of Canada
- Language Industry Association
- Leaders' Roundtable on Commercialization
- MDS Inc.
- Merck Frosst Canada Ltd.
- National Angel Organization

- Natural Sciences and Engineering Research Council of Canada
- Networks of Centres of Excellence (Board Chairs)
- Ontario Furniture Manufacturers' Association
- OrbitIQ
- PARTEQ Innovations, Queen's University
- Pratt & Whitney Canada
- Precarn Incorporated
- QuestAir Technologies Inc.
- Sensor Wireless, Inc.
- SKD Automotive Group (Lustro Steel Products)
- Skypoint Capital Corporation
- StemCell Technologies
- University Health Network

This appendix summarizes some of the key and recurring issues from these submissions. These are organized primarily along the three main themes we selected – talent, research and capital.

Summary of Recommendations from Stakeholder Submissions

Talent

Create Strong Linkages Between Industry and Researchers (Academic and Public)

- Improve linkages between Canada's research institutions and industry, as the interface among researchers, industry and government is the key to commercialization.
- Provide support to institutional research and education programs that require researchers and educators to work in partnership with industry (i.e. that do work of value to the economy).
- Create flexible employment practices at research and development (R&D) institutions so that scientists can easily move from research environments to commercial settings and then back again.
- Create an industrial scholarship program to allow university professors to work in industry for one to three years while retaining their position and tenure at their respective universities.
- Establish a college/institute chairs program focused on applying knowledge rather than developing new knowledge.
- Support Natural Sciences and Engineering Research Council of Canada (NSERC) graduate studentships at "technical" universities, and increase the value of NSERC post-doctoral fellowships.
- Create industrial MSc and PhD programs similar to a Master of Business Administration degree, but with an emphasis on survey courses that provide in-depth knowledge of new and emerging scientific technologies. PhD work would entail studying relevant sectors of the economy and developing business plans to commercialize cutting-edge scientific and technical advances in those sectors.
- Increase international collaborations involving universities and industry.

Build Upon Public Research Infrastructure to Support the Development of Highly Qualified Personnel

- Extend support for public research to address the sustainability of research infrastructure, encourage faculty retention and recruitment, boost Canada's position in global research and its international competitiveness, improve the commercialization outcomes of publicly funded R&D, and support the development of high-quality workers for future needs of business and academia.
- Increase investments in the Canada Foundation for Innovation (CFI), granting councils and other programs that support the public research infrastructure.
- Bring the ratio of CFI infrastructure support to funding agency support to at least 20 percent, which would require $1 billion in additional funding by 2010.
- Increase the funding for the indirect costs associated with research from 29 to 40 percent of the value of research funded by NSERC, the Canadian Institutes of Health Research (CIHR) and the Social Sciences and Humanities Research Council (SSHRC).
- Continue to support the CFI and other granting programs that allow colleges and institutes to gain and renew their research infrastructure.
- Invest additional funding to accelerate the work of the Canada Health Infoway.

Foster Entrepreneurship

- Encourage faculty, graduate students and post-doctoral fellows to bring in speakers from industry to provide mentorship and case studies of successful industrial innovation and commercialization activities.
- Establish a program of Canada commerce chairs to award post-secondary teaching positions to former CEOs and entrepreneurs who want to teach how to grow successful R&D-intensive firms.
- Provide, through government granting agencies, support for post-secondary institutions that offer short courses of study on commerce for the chief executive officers and other employees of R&D-intensive firms.
- Expand WestLink Innovation Network's internship activity to address the scarcity of skilled and experienced entrepreneurs capable of transforming new ideas into products and services that customers want.
- Implement, through Canadian agencies and departments, innovative skills development and entrepreneurship programs based on international best practices in order to foster a culture of commercialization, encourage youth entrepreneurship and risk taking, and promote the transfer of skills (not just money) to SMEs.
- Broaden the non-technical skills of science and engineering graduates.

Talent: Panel Recommendations

- Develop a new Canada Commercialization Fellowships Program.
- Expand existing programs in NSERC, CIHR and SSHRC that spur the hiring of recent graduates.
- Encourage and celebrate young Canadians who aim for success in business, science and technology.
- Develop and retain talent for a global marketplace.

Research

Provide Support to Confirm the Commercial Potential of Innovative Ideas

Investors are increasingly pushing companies to reduce and/or eliminate investment in advanced technology projects until commercial markets develop. Financing is required to bridge the gap between discovery and commercialization; it is also needed in order for firms to survive the many years of high-cash-burning rates and no revenue as they strive to shift their products from the laboratory onto the shelves. In addition, stakeholders recommended the following:

- Encourage market-validation and proof-of-principle activities in order to foster early customer adoption.
- Establish policies, practices and investments to provide information and engineering infrastructure for the design, manufacture and testing of proof-of-concept prototypes to serve as demonstrations in relevant commercial environments.
- Establish strategic investment mechanisms that enable and offer pre-commercial funding for prototype development.

Support Research and Other Innovation Activities of Direct Relevance to Industry

- Establish collaborative research networks that bring together suppliers, research laboratories and anchor businesses in order to improve the level of innovation in supply chains. Larger companies and top-tier suppliers should drive this initiative. Outreach and marketing would be carried out by academic advisory boards, industry associations, university technology-transfer offices and governments. Governments could provide seed funding.
- Create a viable Canadian program to encourage and support multi-partner collaborative research in technology development. Many domestic supply chains have a growing technological disadvantage compared with competitors who benefit from massive, long-term programs.
- Coordinate and sustain government investments in fourth-pillar organizations that bring together business, government and publicly funded institutions to promote, support or conduct science-, technology- or business-practices-based innovation that results in new products, processes or services.
- Target research funding to national commercialization goals and adjust the criteria for research funding approval in order to give equal weight to researchers that have a balance of strong academic credentials and industry experience.
- Support joint academic–industry proposals, and ensure that funding incentives tip the balance of research toward market-relevant innovation that would not occur otherwise.

Support Cluster Development

- Focus government contributions on supporting and nurturing the development of clusters, but refrain from trying to build these from scratch.
- Create a national network to facilitate communication and collaboration among regional networks, industry and government.
- Foster stronger relationships between technology clusters and publicly funded research institutions.
- Develop or expand existing collaborative research networks to include colleges and/or institutes and their faculties. Change the eligibility requirements for the Networks of Centres of Excellence program so that colleges and/or institutes can bring their expertise to these centres.
- Support cluster development:
  - support the development of skilled labour;
  - invest in knowledge infrastructure;
  - use government procurement to enable growth;
  - market Canadian clusters to attract skilled workers, new firms and investment; and
  - gather performance data on clusters in order to bridge current research gaps and improve understanding of cluster fundamentals.
- Establish a process to develop and disseminate technology surveillance and road maps on networking technologies, in support of national strategies. Research is needed on copyright, security and privacy issues that act as barriers to important applications. An interface must be developed and maintained with comparable national initiatives in other countries.

Provide Targeted Support to Innovative Small Businesses

SMEs need capital to support capital expenditures, introduce new products and sustain rapid growth. The modes of government assistance as administered by current programs do not adequately address their needs. Stakeholders recommended the following:

- Provide support for innovative research through a nationwide program of research grants to start-up companies.
- Provide grants — not loans — to help small, research-oriented businesses.
- Implement a uniform SME-funding policy (similar to the Small Business Innovation Research program in the U.S.) for Canadian organizations that undertake or provide significant funding for public research.
- Establish a commercialization development fund to encourage market-driven commercialization research cooperation between Canadian SMEs and research institutes. This would stimulate cooperative commercial development and encourage increased commitment by SMEs to R&D.
- Increase the generosity of the Scientific Research and Experimental Development (SR&ED) tax credit and loans from the Industrial Research Assistance Program and Technology Partnerships Canada in order to cover more than one third of research costs.
- Modify existing financing programs to increase the effectiveness of funds flowing to early-stage SMEs.
- Focus more support on scientist-entrepreneurs and their students and post-doctoral fellows in order to encourage them to commercialize their intellectual property.
- Support university and hospital incubator facilities in order to lower the initial costs of commercialization.
- Provide, through Canadian science and technology (S&T) organizations such as the National Research Council Canada, public infrastructure, services and outreach necessary for Canadian SMEs to access world-leading research capabilities.

- Establish government-funded technology centres for skills training, R&D and advanced manufacturing technologies. These centres would employ high-technology manufacturing specialists to accommodate SMEs through consultation and advice and conducting R&D.
- Expand the Natural Sciences and Engineering Research Council of Canada's College and Community Innovation Pilot Program, based on the success of its initial call for proposals and the interim results of the funded projects.

Enhance Tax Treatment for Expenses Related to R&D and Intellectual Property

- Revisit innovative fiscal mechanisms to enhance firms' access to equity capital (e.g. a refundable SR&ED tax credit for public firms that make R&D investments in Canada, as is presently available for private firms, and flow-through shares).
- Cover, through the SR&ED tax credit program, the costs of obtaining a patent, including professional fees, as obtaining a patent is a key step toward commercialization.
- Enhance the effectiveness of the SR&ED tax credit by including corporate expenses related to the broader innovation process, not just R&D. Specifically, expand the tax credit (on a pilot basis) to include market-assessment activities that take place in conjunction with research activities.
- Provide better recognition of innovation on the shop floor, through the SR&ED tax credit program and other innovation support mechanisms, especially in innovations that involve manufacturing or management-process developments rather than the development of products themselves.
- Introduce early commercialization tax credits for developing and applying key technologies (e.g. environmental and technologically intensive applications).

Research: Panel Recommendations

- Create a Commercialization Superfund.
- Expand federal programs that support seed and start-up firms in proving their business ideas.
- Introduce a Canadian SME Partnerships Initiative.

Capital

Support Local Networks

- Empower and facilitate the role of high-technology-community / member-based organizations and create a leadership role in this area by identifying key organizations that have commercialization mandates.
- Use a national approach to commercialization to operate programs that are close to the market, emphasize enabling technologies, and encourage communities (such as clusters and distributed communities of interest) to drive investments and initiatives.

Enhance Informal Investment

- For all infrastructure investments related to commercialization, require that a minimum of 20 percent of the investment go toward encouraging informal investment.
- Establish and fund angel co-funding (or "sidecar" funds) and promote informal and angel investment whenever and wherever possible.
- Provide incentives for individuals and investors (i.e. angel investors) to provide resources (money and time) to technology SMEs.
- Implement the National Angel Organization's proposal for an innovation and productivity tax credit for small business that would see federal and provincial governments provide investors with a combined 30-percent tax credit for direct investments in eligible businesses.

Improve the Venture Capital Market

A relatively large number of start-up companies are funded, but they tend to receive far less money at early stages than their U.S. competitors. Stakeholders suggested that larger pools of venture capital should be assembled to make larger injections of capital in the early stages of companies' development. This could have the effect of growing companies faster in their early years and making them less susceptible to early buyout. Also, because of the large number of start-ups being funded, there is less money left to finance companies at later stages. Stakeholders felt that more robust and diverse capital markets for later-stage funding and eventual liquidity are required. Stakeholders also recommended the following:

- Establish policies to increase the pool of buyout capital (distinct from venture capital), particularly policies aimed at facilitating management buyouts, as Canada's early-stage, high-technology companies are being acquired by foreign firms at an alarming rate.
- In response to the lack of participation by institutional investors in the Canadian private equity asset class, create a program to reduce the risk to institutional investors while enhancing their expected returns on investments.
- Use seed capital funds provided to the Business Development Bank of Canada to leverage private funds and attract experienced venture capitalists who can provide financing, insight and mentoring to Canadian businesses.
- Work with the Business Development Bank of Canada to create a more positive syndicate environment to provide additional money and guidance to new businesses.
- Encourage labour-sponsored venture capital firms to form syndicates that would participate in buyouts.

Capital: Panel Recommendations

- **Improve access to early-stage angel financing and expertise.**
- **Review the expansion-stage venture capital market.**
- **Remove barriers to foreign venture capital investment.**

Other Areas of Input

Use Government Procurement to Support Innovation

- Ensure that Industry Canada and other government agencies become early adopters of new and groundbreaking Canadian technologies. This can be achieved through program and/or funding arrangements, mitigating risk through monetary and/or technical support, and mandating a certain percentage of procurement activity for this purpose.
- Launch a pilot program to move the government procurement ethos from lowest bid to best value.
- Foster the development and sale of global-best products and services in line with Canadian capabilities.
- Use government procurement policies and programs to foster the adoption of new technology (i.e. government as first user), establish demonstration projects and help smaller companies secure lead or anchor clients.
- Provide incentives in procurement practices for the adoption of new technological innovations (e.g. hybrid or alternative-fuel vehicles).

Improve University Commercialization Outcomes

- Place emphasis in measuring the economic payback of public R&D on its record in creating new companies, new product lines in existing companies, or new processes, rather than on the number of patents or licensing income.
- Improve the impact and effectiveness of knowledge and technology transfer from academia to industry.
- Direct investments to enabling technologies that have broad applications across the economy in order to increase returns on public investments in research.
- Increase targeted funding to support commercialization offices, and award a portion of this funding on a competitive basis.
- Increase training programs for professional technology-transfer staff.
- Establish a national knowledge-transfer office or network of commercialization offices in order to coordinate and monitor the expansion of the infrastructure and capacity needed to accelerate the commercialization of academic research, and to facilitate communication and collaboration among regional networks, industry and government.
- Ensure that the market-driven process of commercialization of publicly funded research occurs successfully by ensuring that the following elements co-exist in a system:
  - companies that commercialize technologies in response to market signals (demand);
  - research organizations, such as universities and government laboratories (supply); and
  - the interface among them (a web of relationships that foster the collaborations, knowledge flows and transactions that make the commercialization process work).
- Increase the capacity of Canadian universities and other institutions to do industrial-quality work. This should be done by providing better facilities and, especially, long-term technical support staff who provide both capacity and continuity much more effectively than do the graduate students who customarily carry out much of day-to-day research. (The availability of technical support staff accounts for much of the higher capacity for industrial-quality research in Europe.)

Improve Canada's Intellectual Property Regime

- Improve the Canadian intellectual property system so that it is comparable to or better than those in place in other countries. Issues include long delays in processing trademark and patent applications, loss of intellectual property rights for reasons not related to the basic principles of the patent and trademark systems, time extension and sequence listings.
- Adopt a patent-term restoration policy that recognizes potential delays in the patent approval process and ensures predictability in the market.
- Ensure that data-protection policy provides for the proposed eight years of effective protection in order to encourage invention in Canada and to ensure that innovators can reasonably expect a period of data exclusivity. Under the Agreement on Trade-Related Aspects of Intellectual Property Rights, Canada has had an international obligation to provide data protection since 1995.
- Address the fact that the *Patent Act* does not allow for the patenting of higher life forms, as Canada is alone among its major trading partners in not permitting the patenting of higher life forms.
- Implement a single, uniform system to manage intellectual property resulting from federally funded research, similar to the *Bayh-Dole Act* in the U.S. This would ease access to intellectual property for Canadian firms, increase efficiency in the commercialization process and create technology platforms that involve multiple sets of intellectual property rights.
- Develop an equitable, realistic policy regime for intellectual property ownership that is uniform for all research institutions across Canada and is aimed at the needs of industry to protect investments made in research.
- Allow intellectual property generated in universities to be owned by the faculty and students involved. These researchers could then be encouraged and supported to become entrepreneurs.

Provide Market Information

- Provide reliable market data, solid figures on market potential, and competitive information so that company owners who want to tackle a new market can make sound decisions.

Improve Program Delivery

- Improve federal program delivery, as existing government programs contain onerous paperwork and entail too much ongoing government involvement for SMEs.
- Create a streamlined, more consistent approach to federal program delivery for industry (e.g. a single-window system), as such an approach would be extremely helpful for industry. Applicants must currently contend with different application procedures, different eligible costs, different decision-making processes and different contracts for each program. Fuel Cells Canada has noted the existence of 32 separate programs offered by 20 separate departments and agencies for the promotion of fuel cells and hydrogen. Delivery systems within the federal government are fragmented, and agencies are sometimes at odds with each other.
- Eliminate "no-stacking" funding policies. Funds from two or more government or government-related agencies (e.g. Sustainable Development Technology Canada) cannot currently be used to support the same activities (i.e. they cannot be "stacked"). The government and its various relevant agencies should agree that it is acceptable to stack up to 75 percent of government funds for R&D and demonstration projects in key areas (e.g. green technologies).

Sector-Specific Input

The panel also received submissions that focused on sector-specific issues in such areas as the automotive, information and communication technology, life sciences, and construction industries. We recommend that the Commercialization Partnership Board consult these submissions when designing and carrying out its future program.

Appendix L

Reviewers

To ensure that our report would be of high quality and relevant to the challenges facing Canada, we asked eight prominent and learned Canadian and international experts to review a draft version of the report. In addition to commenting specifically in their individual areas of expertise, reviewers were asked to comment on the following:

- Does the report fulfill the panel's terms of reference? If not, in what areas is it deficient?
- Does the report have sufficient breadth to provide the Government of Canada with sound policy advice on commercialization?
- Have the topics covered in the report been researched and analyzed in sufficient depth to justify our analysis, conclusions and recommendations? Is the most recent thinking on commercialization and related issues reflected in the document, and has the most relevant and recent data been used?
- Does the report indicate that we have treated the topic with independence, objectivity and balance? If not, what elements appear to contain unjustified bias or lack of balance?
- Are the recommendations sound – i.e., are they based on the most relevant evidence and data, and do they fit together as part of an integrated approach to resolving the issues identified? Are they the key priorities for government action?
- What are your views on the Commercialization Partnership Board? Would it be effective in allowing the private sector to influence and lead the commercialization agenda?
- Can the recommendations be implemented in a cost-efficient manner that would have a positive impact on improving Canada's commercialization record? Are the next steps clearly defined?
- Will the report be effective as a communications tool? Are arguments and recommendations stated in clear, easily understood language for readers inside and outside government?
- Does the report lend itself to private sector as well as public sector buy-in?

Although we remain responsible for the contents of the report, we are grateful for the insights provided by the reviewers. Their helpful comments and suggestions have strengthened our recommendations and resulted in a much-improved document. In particular, reviewers' comments have prompted us to provide more evidence to support the need for action and to emphasize demand considerations more forcefully throughout the report.

Reviewers

H. Douglas Barber, MSc, PhD, FCAE, PEng
Distinguished Professor-in-Residence, Engineering Faculty, McMaster University, and co-founder and former President and Chief Executive Officer, Gennum Corporation

Dr. H. Douglas Barber obtained his MSc in Electrical Engineering in 1960. As an Athlone Fellow and North Atlantic Treaty Organisation Scholar, he received his PhD from The Imperial College of Science and Technology in London, England, in 1965.

Dr. Barber is the former President and Chief Executive Officer of Gennum Corporation, a company he co-founded in 1973. He is currently a member of Gennum's Board of Directors. He is Past Chair and a continuing member of the Board of Governors of McMaster University, and a Director of DALSA Corporation, Micralyne Inc., and NetAccess Systems Inc. He was a founding member of the Canadian Semiconductor Technology Conference, the Canadian Microelectronics Corporation, the Sectoral Skills Council, the Canadian Semiconductor Design Association, Micronet and the Strategic Semiconductor Consortium.

Dr. Barber is a member of the Professional Engineers of Ontario, The Electrochemical Society and the Institute of Electrical and Electronic Engineers. He is Distinguished Professor-in-Residence at the Faculty of Engineering at McMaster University. From 1996 to 2002 he was a member of the Natural Sciences and Engineering Research Council of Canada, and from 2000 to 2003 was the Vice-Chair of the Ontario Science and Innovation Council.

Dr. Barber is a member of the Commercialization Advisory Council of the Ontario Ministry of Economic Development and Trade and a member of The Conference Board of Canada Leaders' Roundtable on Commercialization.

Francesco Bellini, MSc, PhD, OC, OQ, GU
Chairman, President and Chief Executive Officer of Neurochem Inc., and co-founder and former Chairman and Chief Executive Officer, BioChem Pharma Inc.

Born in Italy, Dr. Francesco Bellini came to Canada in 1967. He received his BSc from Loyola College (now Concordia University) in 1972 and his PhD in organic chemistry from the University of New Brunswick in 1977. He is the author or co-author of some 20 patents and has published numerous articles and papers based on his research.

From 1968 to 1984 Dr. Bellini had a fruitful career as a researcher at the Canadian subsidiary of a multinational pharmaceutical company. In 1984 he established the Biochemicals Division of the Institut Armand-Frappier at the Université du Québec, which specializes in research, manufacturing and the commercialization of fine chemicals. Dr. Bellini left this unit in 1986 to co-found BioChem Pharma Inc., an innovative biopharmaceutical company focused on infectious diseases and cancer. In addition to being co-founder, he was also the company's Chairman and Chief Executive Officer from 1986 to 2001.

Dr. Bellini is now Chairman, President and Chief Executive Officer of Neurochem Inc., an industry leader in the development of therapeutic drugs for the central nervous system. He is also Chairman of Picchio International Inc., Picchio Pharma Inc., Adaltis Inc., Innodia Inc., and Virochem Pharma Inc. – all companies involved in health care.

For his major contribution in the fields of entrepreneurship, research and the economy, in 2005 Dr. Bellini received the title of Cavaliere del Lavoro, the most prestigious honour granted by the Italian government. He was named an Officer of the Order of Canada in 2000, and an Officer of the Ordre national du Québec in 2004.

Daniel Malkin

Deputy Manager, Inter-American Development Bank, and former Head, Science and Technology Policy Division, Organisation for Economic Co-operation and Development

Daniel Malkin was appointed to the Inter-American Development Bank in September 2005 as Deputy Manager in Charge of Education, Science and Technology, in the Bank's Sustainable Development Department.

From 1999 to that date he headed the Science and Technology Policy Division of the OECD Directorate for Science, Technology and Industry. His activities there focused on assessing OECD member countries' S&T and innovation policies and public support for R&D; the performance and governance of science and innovation systems; the development and mobility of human resources in S&T; and, more generally, the contribution of S&T toward productivity and economic growth. This work led to the formulation of recommendations to high-level officials in charge of S&T in OECD countries.

Prior to his joining the OECD in 1986, Mr. Malkin held several posts in the French administration, the last one as Head of the Planning Commission's Industry and Technology Department. He graduated from the École Polytechnique in Paris and completed his post-graduate studies as a Fulbright scholar at the University of California, Berkeley and the Wharton School of the University of Pennsylvania.

Roger L. Martin, AB, MBA

Dean, Joseph L. Rotman School of Management; and Chair, Ontario Task Force on Competitiveness, Productivity, and Economic Progress

Roger L. Martin has served as Dean of the Joseph L. Rotman School of Management at the University of Toronto since September 1998.

A Canadian, originally from Wallenstein, Ontario, Mr. Martin was formerly a Director of Monitor Company, a global strategy consulting firm based in Cambridge, Massachusetts. During his 13 years with Monitor Company, he founded and chaired Monitor University, the firm's educational arm, served as Co-Head of the firm for two years and founded its Canadian office.

His research interests lie in the areas of global competitiveness, integrative thinking, business design and corporate citizenship. He has written five *Harvard Business Review* articles and published his first book, *The Responsibility Virus* (New York: Basic Books, 2002). He writes extensively on Canadian competitiveness policy in *The Globe and Mail, National Post* and *Time Magazine*. Mr. Martin is also a regular columnist for *Business Week Online*'s Innovation and Design Channel, and is currently Chair of the Ontario Task Force on Competitiveness, Productivity and Economic Progress.

In 2004 Mr. Martin won a Marshall McLuhan Visionary Award, and, in 2005, was named one of *Business Week*'s seven innovation gurus.

He received his AB, with a concentration in economics, from Harvard College in 1979 and his MBA from Harvard Business School in 1981.

Mr. Martin is the Chair of Workbrain, Inc.; serves on the boards of The Thomson Corporation, Tennis Canada, the Canadian Credit Management Foundation and Skoll Foundation; and is a trustee of The Hospital for Sick Children in Toronto. He also is on the advisory boards of Butterfield & Robinson, Social Capital Partners, and Jefferson Partners, and is a founder of EMAGINE.

Eric Newell, MSc, LLD, OC

Former Chair and Chief Executive Officer, Syncrude Canada Ltd., and Chancellor, University of Alberta

Eric Newell is Chancellor of the University of Alberta. He is also the retired Chairman of the Board and Chief Executive Officer of Syncrude Canada Ltd., positions he held since May 1994 and August 1989, respectively. He also served as President of Syncrude from 1989 to 1997. Prior to joining Syncrude, Mr. Newell worked with Imperial Oil Limited and Esso Petroleum Canada. As past President of the Alberta Chamber of Resources, he spearheaded the creation of the National Oil Sands Task Force, which developed a comprehensive new energy vision for Canada in 1995.

Mr. Newell holds a BASc in Chemical Engineering from the University of British Columbia, and an MSc in Management Studies from the University of Birmingham in England. He is an Officer of the Order of Canada and a member of the Alberta Order of Excellence.

Mr. Newell is a Director of Canfor Corporation and Nexen Inc. He is also Chair of CAREERS: The Next Generation Foundation, and a member of the boards of the Alberta Energy Research Institute, the C.D. Howe Institute, the Alberta Heart Institute, the Lieutenant Governor of Alberta Arts Awards Foundation and The Learning Partnership.

Kenneth H. Norrie, MPhil, PhD

Provost and Vice-President (Academic), McMaster University

Dr. Kenneth H. Norrie earned an honours degree in economics from the University of Saskatchewan in 1967, an MPhil from Yale University in 1969 and a PhD from Yale in 1971. He joined the University of Alberta in 1971, and was promoted to full Professor in 1980. Dr. Norrie was Associate Dean of Arts (Social Sciences) in 1989-1990, Acting Chair of the Economics Department in 1993-94, Chair of the Economics Department in 1997-1999, and Dean of Arts from July 1, 1999, to December 31, 2001. He joined McMaster University on January 1, 2002, as Professor of Economics and Provost and Vice-President (Academic).

Professor Norrie spent the 1979-1980 academic year as a Visiting Associate Professor at Queen's University, and was seconded to the Royal Commission on the Economic Union and Development Prospects for Canada (the Macdonald Commission) in 1983-1984 and 1984-1985. In 1990-1991, he was the Clifford Clark Visiting Economist at the Department of Finance, Government of Canada. Dr. Norrie was also the editor of *Canadian Public Policy* between 1986 and 1990, and has served on the editorial boards of the *Canadian Journal of Economics*, the *Canadian Journal of Regional Science, Prairie Forum* and *National History*.

Professor Norrie's teaching and research interests lie in the areas of Canadian economic history, regional economics and economic policy. He is the author or co-author of five monographs, including *A History of the Canadian Economy*, 3rd edition (Kenneth Norrie, Douglas Owram and Herbert Emery, eds.; Toronto: Harcourt Brace, 2002). He has published articles in the *Canadian Journal of Economics*, the *Journal of Economic History, Canadian Public Policy, Agricultural History, Canadian Papers in Rural History, Canadian Journal of Political Science, Economy and History*, the *Journal of Canadian Studies, Explorations in Economic History* and *Publius: The Journal of Federalism*. He has also published a number of book chapters and papers in conference proceedings.

Harry Swain, PhD, LLD

President, Trimbelle Limited; Executive Director, Canadian Institute for Climate Studies; and former Deputy Minister, Industry Canada and Department of Indian and Northern Affairs Canada

Harry Swain is President of Trimbelle Limited, a management consulting company. He is also Executive Director of the Canadian Institute for Climate Studies at the Centre for Global Studies at the University of Victoria.

Mr. Swain worked in nine federal departments between 1971 and 1995, not counting two years at the International Institute for Applied Systems Analysis in Laxenburg, Austria, and one in the British Columbia government. He was Deputy Minister of the Department of Indian and Northern Affairs Canada during the Oka standoff in 1990 and the constitutional wars, and was Deputy Minister of Industry Canada when the modern department was created.

On leaving the Canadian federal government, Mr. Swain became Chief Executive Officer of Hambros Canada and a Director of its U.K. merchant banking parent. When Hambros was bought by Société Générale, he stayed on for the transition but left in September 1998 to found the Toronto office of Sussex Circle, a consultancy firm concentrating on strategic and financial advice for public and private sector clients. Mr. Swain was the Toronto partner in Sussex Circle from 1998 to 2002. He has also served as Chair of the research advisory panel for the Walkerton inquiry and as Chair of the subsequent expert panel on water and wastewater strategy for Ontario.

Mr. Swain holds a PhD in Economic Geography from the University of Minnesota and an LLD from the University of Victoria, and has taught at the University of Toronto and the University of British Columbia.

Jacquelyn Thayer Scott, PhD, LLD (Hons), OC

Deputy Chair, Prime Minister's Advisory Council on Science and Technology; Professor of Organizational Management and Public Administration, Cape Breton University

Dr. Jacquelyn Thayer Scott is Professor of Organizational Management & Public Administration at Cape Breton University in Sydney, Nova Scotia, and Deputy Chair (Operating Head) of the Prime Minister's Advisory Council on Science and Technology. From 1993 to 2002, she was President and Vice-Chancellor of Cape Breton University (then known as University College of Cape Breton). She has also served as Director of the School of Continuing Studies at the University of Toronto, and on the faculty at the University of Manitoba. She has operated her own public relations and management consulting firm, and has been employed as a journalist by The Canadian Press and *The Columbian*.

Dr. Scott currently serves on a number of governing boards and advisory committees, many of them related to science, technology and innovation, including the Premier's Council on Innovation in Nova Scotia; the Canada Millennium Scholarship Foundation, Government of Canada; InNOVAcorp in Nova Scotia (as Chair of the Governance Committee); DynaGen Technologies Inc; CrossOff Incorporated; and the RCC College of Technology. She is also a former chair of the boards of CANARIE Inc., The Canadian Alliance of Education and Training Organizations, the Canadian Association for University Continuing Education, and the Ontario Council for University Continuing Education.

Dr. Scott was appointed as an Officer of the Order of Canada in 2001 and was awarded the Queen's Golden Jubilee Medal in 2002.

Appendix M

Selected Bibliography of Commercialization

Canadian Non-Governmental Organizations

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